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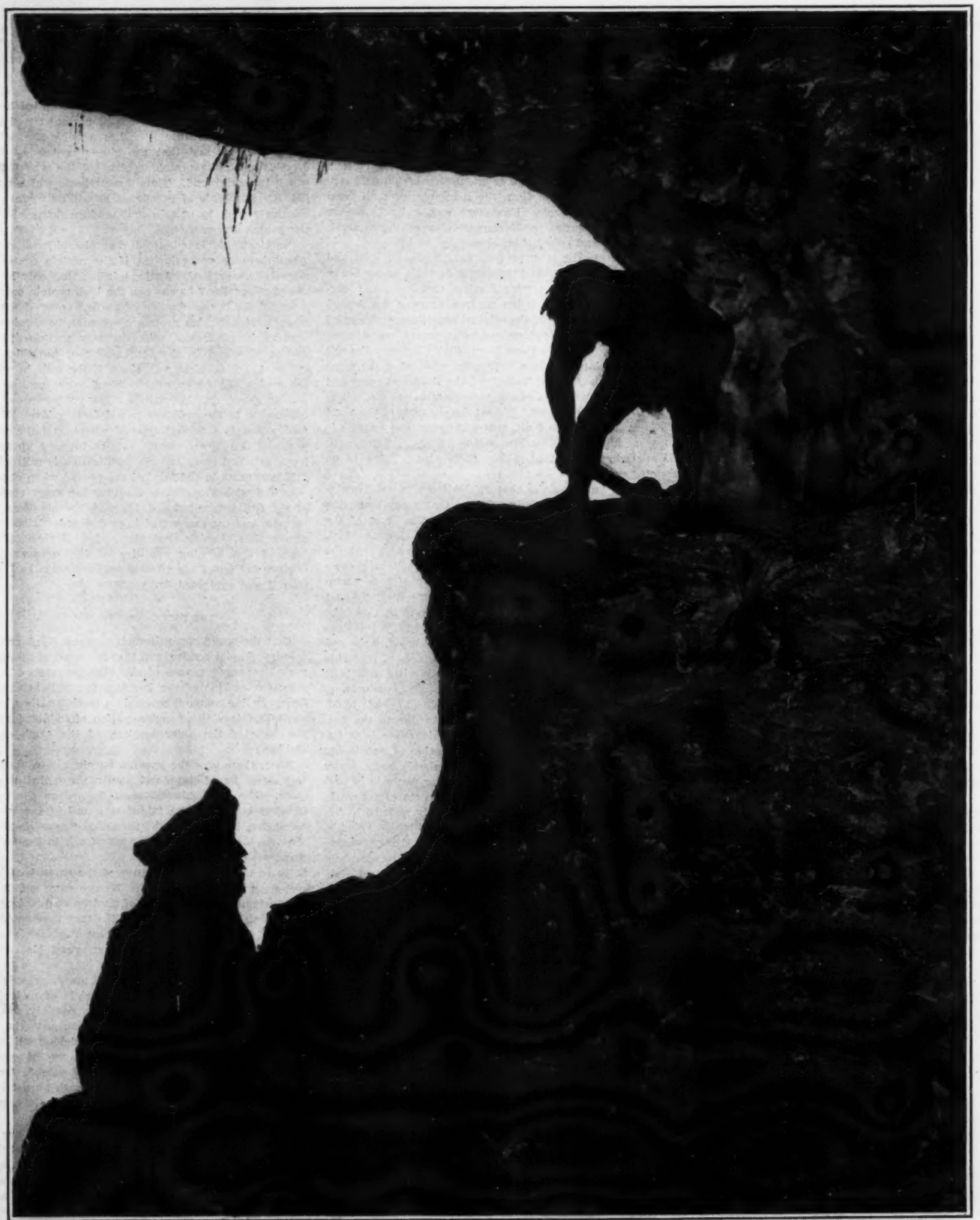

Photo by Cosmos Studio, Inc.

Stone Age scene. Restoration by Dwight Franklin of Home Life of Cave Men and Women. Period of the Neanderthals and the Glacial Epoch

POPULARIZING ANTHROPOLOGY—[See page 408]

The Rejuvenation of Earth and Man*

Clean Culture Nature's Method

By Sampson Morgan

Is the earth in its dotage? Have its vital and productive powers declined and fallen into decay? Let us see.

The cooling of the earth's surface when it reached the stage suitable to the advent of organic forms marks one of the most remarkable epochs in the whole history of biology. The consummate material order in the universe, even to the most minute details, shows, to my mind, the existence of a consummate moral order.

"It cannot," as one writer says, "be blind gravitation and affinity that were able to bring forth and adapt all this." The most reasonable explanation appears to be, that matter, mind and life are one, and that matter being intelligent exercised the powers it possessed of transmitting life to organic forms here, when the declining temperature of the earth's crust fitted it for their appearance. The demonstration of science that life can only come from life is unassailable, yet there is no great gulf between the living and non-living, as Prof. Huxley suggested there was. Prof. Drummond not only agreed with Huxley, but claimed that a barrier exists which separates mind from matter.

But there is no "missing-link" in the chain of argument to the contrary, for it was forged by nature and is perfect in every detail. Life is not, as Prof. Drummond said, a bending down to but an uprising from the inorganic world. The vital thread in eternal continuity runs through the organic and inorganic spheres. It was the universal, inherent, intelligent tendency which particles of dissimilar bodies have to combine and form new compounds and structures which, under the resistless and restless moulding influence in Nature, first transmitted life through lowest organic forms to earth.

The oneness of the world is undoubted, and we are part and parcel of it. Life is a continuous series of changes, not only in this world but in every sphere everywhere. There is no death, only a transformation in the form of matter. If microbes, mammoths, men, worlds and systems disappear from view they do not die. They are still subject to the law of cohesion, or close union of parts, and continue, in some form or other, to maintain their uninterrupted connection with the unbroken texture of the visible or invisible universe which is eternal.

Wherever history throws its illuminating beams upon the acts and thoughts of men it discloses to us the fact that in every age the pessimist was as much in evidence in the past as in the present. "Persistent and over cultivation of the soil has seriously affected its vital and productive powers. The earth is played out," and so on, they said in the days of Homer, and the gloomy views are upheld to-day in many quarters.

Seneca spoke of "the senility of the soil." Hehn refers to the discreet opinions of Franz Unger, who, in refutation of the pessimists in fertility, practically said there is no such thing as the senile marasmus of Nature. "The ground has lost nothing of its creative fire. In its subjugation and improvement it only requires assistance." Brains count more than brawn. Change and improve the men who inhabit and till the ground and the earth will smile through such bumper harvests of glowing fruits and golden grains as few of our cleverest thinkers conceive possible.

Nevertheless, some of the opinions of Hehn himself in this connection are pessimistic and erroneous. I insist that the golden age of soil productivity in Europe, Asia and Africa is not behind but before us. Clean culture, Nature's method, is capable of making the miasmatic swamps of the tropics as sweet and healthy as England, and the huge deserts even of Africa fertile beyond description.

In expressing my views on the subject to an ex-admiral of the British navy, who is now interested in the intelligent cultivation of his own estate, he replied, "You are perfectly right, I am sure, of the enormous importance of your clean culture method to the tropics."

A distinguished West Coast African treaty maker whom I saw at the Colonial Institute was quite enthusiastic over its value, and in a long interview expressed the opinion that it would do more than anything he knew of to develop lucrative food producing industries there. He paid me the compliment of saying, "You are the first man I have met who understands the situation. You are right; Western Tropical Africa may be made a grand and heathy field of activity for white labor by clean culture. I do wish you would come with me to the West Coast when I go next month."

He fully agreed with me as to the tremendous possibilities of the West Coast as an agricultural El Dorado for the world.

DARWIN, HENSLOW AND CLEAN CULTURE.

Whilst the Darwinians say that a plant survives because of some superiority in the structure of its flower, Prof. Henslow says that a seedling survives because it is vigorous. But he stops short at the most critical point in the argument. Like the Darwinians, he fails to see that though the survival of the fittest is the survival of the most vigorous, the survival of the most vigorous is the survival of the best fed. I therefore hold that both Darwin and Henslow overlooked the chief force in the situation. Bacon was nearer the truth than either of them. There is no Natural Selection no more than there is an unsurpassable gulf separating the organic from the inorganic, or man from the lower mammals. Food ever was and will be the basis of progress or of retrogression in the mineral, vegetable and animal kingdoms.

What are the most perfect plant foods for soils and crops? Is it possible to maintain fertility under heavy persistent cropping with forcing chemicals and carbonate of ammonia laden manure, or must we depend upon the provision of the original constitutent elements?

Before these questions can be answered properly we must recognize that there is an affinity between the soil and the plant and tree. We must admit that the wood of trees, the flesh of fruits, and the tissues of roots and grains are composed of the same elements as the soil in which they are grown. We eat the elements of the plant foods fed into the fruit, root and grain, and as man is what his food makes him so the products of the earth are what their food makes them also. There is no difference.

Some experts claim that cultivation alone will maintain fertility indefinitely. Others that green manuring in some form will suffice, and many that dust of the disintegrated rock will furnish the one thing needful. Though some of our greatest geologists assert that the original soil consisted of disintegrated rock, they overlook the fact that soil is not made up of rock exclusively. The late Prof. Thorold Rogers said, "Wheat will not grown on a granite rock, but if this rock be disintegrated it makes the most fertile soil." But does it? The disintegrated rock formed the basis of the soil in the beginning but no more. Soil consists of vegetable and mineral amalgamations, and only with such is it possible to enjoy perfect crops and perfect products.

The physical degeneracy observable on every hand, both in country and town, is mainly due to the persistent consumption of foodstuffs which have been imperfectly grown, and are thus incapable of nourishing the body. Analysis of the flesh of animals, roots, fruits and grains proves that under existing methods of production 75 per cent. of the internal structures are weak, watery and unhealthy, and consequently unfitted to fulfill the purpose for which they are utilized. Animals, roots, fruits and grains, fed with weak disease engendering "foods," cannot possibly produce vitalizing robust tissue, and such when consumed is incapable of elaborating disease resisting tissue in man.

I have in my experiments with plants and soils demonstrated the positive affinity between perfect food and health, and imperfect food and disease. Since then Prof. Potter, in a paper at a British Association meeting, endorsed clean culture in my words as follows: "Susceptibility to disease is influenced by manural treatment in the vegetable kingdom, and high fertilization with nitrogenous manures lowers the power of the plant or organism to resist infection."

Before bacterial disease in the vegetable kingdom can be effectually dealt with these facts must be recognised openly and generally. The maintenance of fertility in the soil is due to the unimpeded activity of minute organisms. Their activity depends upon congenial conditions and perfect food. The laws of Nature dominate the life of the microbe as well as that of the mammoth.

Chemical analysis has demonstrated that in wheat growing countries the quality of the bulk of the grain produced is of low food value. The two kinds of wheat, *Triticum durum* and *T. vulgare*, offer us object lessons well worth consideration. The former is hard, the latter soft. In soft grains the water percentage ranges from 10.0 to 16.0, and in hard grains from 5.0 to 10. In soft wheat the starch percentage is 65.0, in hard it is 48.0. The gluten percentage in soft wheat is 10.0, in hard wheat it is 19.0.

The soft wheat contains more water, more starch and less gluten; the latter, of course, being of the utmost importance in building up health of body and brain. The flinty grain cannot be grown to perfection with carbonate of ammonia laden manure. The agricultural chemists cannot maintain the hard flinty glutinous character of wheat grains by the present method of fertilization.

The latest results, secured at one of the leading Experimental Stations in the United States, led to the conclusion that gluten is the most important constituent of wheat flour, because it makes possible the baking of light bread, and that the gluten content of flour depends upon the protein content of the wheat from which it was ground. Thus those wheats which establish the standards of excellence in milling centers are relatively high in protein and produce flours of relatively high gluten content.

Practically it is admitted that the objects of the wheat breeder are valueless if the protein content is materially sacrificed. Again, I insist, that only by the use of mineralized humus can the high protein content, essential for the production of perfect crops of perfect wheat grains of high protein percentage, be obtained.

Plant breeding and selection may produce higher grades of wheat in the future as they have done in the past, but to what end, since, if the soils in which the grains are grown are fertilized with manure and forcing chemicals, they will in a few years run out and degenerate to the ordinary unsatisfactory level. Macaroni wheat is a perfect type of wheat, and the softer fleshed home-grown wheats can be brought up to its level, provided clean culture fertilization is utilized.

Experiments in California have proved when oranges were fed with nitrogenous manures the sugar contents of the fruits were reduced, the flesh became of coarser texture, and the amount of juice declined. It was also shown that they delayed the period of ripening and lowered the keeping qualities of the oranges. All manure fed fruits are affected in these ways as I have proved and explained for years.

THE EARTH BONFIRE ASH.

That the world came through a titanic conflagration, a huge celestial bonfire, and that the crust of the earth, with its rugged ranges of sky high mountains, is the resultant residue of the burning, few will attempt to deny. In due course it reached its meridian, then began to decline, leaving a conglomeration of solidified ash in the form of the outer coatings of the earth as its residue.

First, there was the gaseous burning state, then the melting or liquid state, and finally, the cooled or solid state. The hard mineral crust formed on the earth, in what is termed the "third stadium" of the world's formation, brings us to the time of the consolidation of the rocks, such really consisting of ash in compressed form.

No sooner had the structure of the earth been completed than mighty forces of Nature were set in motion, grinding down the face of the iron clad rocky crust into particles so fine and dust-like that they could not be seen by the human eye. These dust-like mineral particles together with decaying vegetable matter formed the first soil.

Though in some forms of sedimentary, organic and igneous rocks we have ample materials of undeniable importance for fertilizing purposes, possibly granite, a crystalline rock of considerable beauty, is the best for enhancing soil fertility and enriching all crops naturally. There are enormous ranges of granite masses in Wales, Cumberland and Scotland, for instance. In the lowest layers of the earth's crust incalculable quantities exist, formed possibly mainly in the Azoic age.

So immense are the masses of rocks beneath our feet that it is impossible to get down to the bottom of them. Nevertheless, thanks to the titanic upheavals which have taken place under the tremendous influences of the irresistible forces of Nature, colossal hills and mountains of granite have been forced upwards through the earth's crust into the air, in some instances

* From the *Chemical News*.

reaching such a height that their peaks look as if they would pierce the skies.

In these masses we have offered us by Nature the most perfect form of mineral plant food for all crops that it is possible to obtain. All that is needed is to grind down these blocks of solidified dust to fine powder, which, when mixed with uncontaminated vegetable humus making material, furnishes the most perfect combination that can be fed to the soil.

According to my clean culture teaching, bonfire ash is one of the mightiest factors, not only in the production of perfectly healthy worlds but of perfectly healthy soils, vegetable and animal cells, beneficent bacteria, grasses, plants, trees, mammoths and men.

The new earth—that is, the clean earth—lies at the basis of all perfection. The soil has been fouled with the filth of civilization. Incinerate it, and what charming scenes and surroundings would be brought about. The importance of purification by fire has been ignored too long, at least by Western nations. The ashes from these fires are of untold value to the cultivator of the soil, and by ceasing to poison the earth by souring it with foul smelling "plant foods," and by letting in the light air and sun, and mineralizing it with the sweet refuse of these burnings and with granite dust, we should soon increase the productive powers of the earth a hundredfold.

Exhaustion by culture is a contradiction in terms. The thing is impossible. Soils are not impoverished by culture but by the want of it. Millions of acres of unproductive land in Britain are crying out for the bland non-forcing mineral which I commend. One authority estimates that one river alone carries annually 150,000,000 tons of dissolved rock materials to the sea. Science has performed wonderful feats. It has even picked up sounds and photographed them. Would that it could separate and pick up the fine particles of fertilizing rocks, billions of tons of which the mighty rivers have been permitted to carry away from the land and fling into the depths of the mighty deep.

In experiments, by digesting powdered felspar, hornblende, and other minerals with water for a week, from a third of 1 per cent. to 1 per cent. of the mineral was dissolved out by the water. The opinion that granite because of its hard texture is of little use in modern land fertilization has no foundation in fact, as the above shows.

The ordinary farmer and gardener know little about the dissolving properties of rain-water, or understand that the presence of simple particles of the primary rocks in the cultivated soil are necessary to assure the elaboration of healthy supple tissue in the animal organism, or flexibility in flax, in the stem or grain of grain bearing plants and the branches of fruit trees.

The potassa in the granite is worth its weight in gold to the English and Irish flax growers, who cannot by any possibility produce that pliancy of thread which is the chief characteristic of flax of the highest commercial quality. It is utterly impossible to grow supple flax of the finest grade with carbonate of ammonia laden manure or forcing chemicals.

French, Spanish and Irish linens lack suppleness, fineness and durability, due in the first and second cases to an excess of lime, which makes for brittleness, and in the third case to an excess of manure, which makes for weakness in plant tissues. Suggestions for increasing the flexibility of the blood vessels of the human body will be found in my paper on "Fruits for Health, Strength and Longevity" in the *Fortnightly Review*.

Andrew Knight and Charles Darwin both held that excess of food was the most powerful factor in plant variation. It is certainly not the vital factor in plant progress, for excess of food in either the vegetable or animal kingdom makes for sterility rather than fruitfulness.

Prof. Bailey says, "The richer the soil in available plant food the stronger will the products be." I doubt it. Life-long experimentation has taught me that an excess of plant food tends always to the demoralization of plant tissues and of the productive powers of soils.

On one acre of pasture clean culture fed a bullock can be kept and fattened without the purchase of feeding cakes and such like, whilst on the majority of farms three acres are necessary, even with the addition of cake, and on others, again, five acres will not suffice for the purpose. This scandalously wasteful system has been permitted to continue for generations. The only remedy for this state of things is the standardization of cultivation, the necessity for which I have insisted upon for years. A Welsh gentleman farmer has written testifying to the remarkable manner in which clean culture has improved the nutrient quality of his pastures, increasing the milk and cream output and improving the quality of both.

THE GOLDEN RULE OF SANITATION.

Sir Benjamin Ward Richardson, the great authority on health, and his friend, Sir Edwin Chadwick, the well-known sanitarian, would not have written as they did in favor of fertility through sewage and farm-yard manure, both soil sourers and poisonous, had they seen the new circle of life which I have put forward as the basis of my clean culture theory.

"The sewage to the land," said Sir Benjamin, "is the golden rule of sanitation." I doubt it. Do you eat these cabbages yourself, I asked the engineer of a sewage farm who managed the steam plant and crops. "No, indeed; I should be very sorry to; I sell them." He knew more about the real golden rule of sanitation than he did about the golden rule of morals.

The man who first introduced the dust destructor to civilization deserves a statue of gold to his memory. He did more to lead humanity back to actual First Principles than did Herbert Spencer. The reduction of the whole of the filth of civilization to purified ash will mark a tremendous step towards the advent of the greatest of all ages—the clean age.

Utilizing the Skins of Sharks and other Acquatic Animals

WITH a view to utilizing a variety of new material for which it is believed that many new and important uses will be found, the U. S. Bureau of Fisheries has distributed among a number of persons or firms interested in the subject, the raw hides of several hundred sharks and a number of hides of other forms, including cod, hake, grouper, gar, rays, catfish, wolffish and porpoise. This has relieved the tanners of difficulties attendant on obtaining small quantities of skins for experimental purposes, has enabled them to determine whether their methods of tanning were suited to the making of good grades of leather from fish skins and for those who developed further interest to conduct experiments to determine what methods would yield the best results. The interest of a number of tanners has been aroused. They have developed methods for tanning fish skins which they claim will produce good grades of leather and are now seeking supplies of certain classes of fish skins.

The need for using these skins is twofold: (1) To relieve the shortage of raw products used in the manufacture of leather, and (2) to provide a market for a product of the fisheries for which there was little or no existing demand. To insure supplies of the raw products, it has been necessary to determine methods for removing the skins from the aquatic animals in a manner best suited to the tanners' needs, how they should be cured and boxed for shipment, the fishermen furnished with this information and the names of persons in the market for the raw products. This also the Bureau has endeavored to do.

The third step is to determine the uses to which these leathers are best suited. While the tanners are in better position to develop markets for the leathers than the Bureau, it has endeavored to be of assistance in this field. Tanned leathers sent in by the tanners have been submitted to the Bureau of Standards for testing as to tensile strength. The attention of persons engaged in the manufacture of leather goods has been called to these products and in other ways the Bureau has given assistance.

Of the various fishes, the sharks appear to give the greatest promise. Formerly large quantities of these skins, cleaned but not tanned, were used for polishing wood, ivory and the like. Because of the roughness, hardness and durability of the outer surface, they were especially serviceable for that purpose. Although sandpaper and emery preparations have largely replaced such materials, there is still a small demand among cabinet makers for certain of these hides. Tanned shark skin leathers have also been used to a limited extent for various ornamental purposes. In this connection, the question of supply is of importance. In the absence of an established fishery for sharks, it is difficult to estimate the total supply the fisheries are capable of furnishing. It is known that considerable quantities of sharks are taken each year in the nets of our coastal fishermen, that the sharks are of wide distribution occurring not only in all warm seas but even in cold Arctic and Antarctic waters. Two items in this connection may be of interest. According to the *Pacific Fisherman*, 11,600 pounds of shark skins were landed in Puget Sound ports last December. These were all from southeast Alaska and it is believed were obtained by one small company. A man in Honolulu, T. H., estimates that he can bring to that port from the south seas 800 tons of these skins per year.

In order to insure the interest of the fishermen in this fishery the Bureau is now endeavoring to develop a market for the meat of the shark salted and smoked, which it believes to be a good food product. Grayfish, species of small sharks, abundant in New England and on the west coast, have for more than a year been canned in considerable quantities as a result of the Bureau's efforts. In addition, shark livers are rich in a marketable oil and the fishermen are furnished with information as to the method of extracting this oil.

In preparing the hides of sharks for the market all body fins should be removed by cutting them off as close to the body as possible without injuring the skins. An incision is then made around the head, just back of the mouth, and also around the base of the tail; and a cut is made down the back, connecting the above incisions. The skin is now carefully removed, and stretched around a beam-like surface and all superfluous meat is carefully removed with a sharp knife.

Great care should be exercised not to cut the skin while dressing it, and it should be remembered that knife cuts and fork holes reduce the value of the hide.

After dressing the flesh side of the skin is thoroughly rubbed with salt, and then the side flaps are folded in, and the skin rolled up into a compact bundle. After 24 hours the skin is unrolled, the water drained off, and the skin resalted, rolled up as before, and left three or four days to cure. It is now ready for shipment, after the loose salt has been shaken off.

Hawaiian Poi

HAWAII is making a food-saving contribution in the shape of poi, its national dish made from the bulb of the taro plant. Until 20 years ago poi was made under primitive conditios, the bulbs being peeled, boiled, and pounded in a wooden trencher until a semiliquid paste was formed. But today modern sanitary machinery is used to manufacture the product, under supervision of health authorities in the island, and five factories at Hilo now turn out several tons daily. This new form of poi is being sent to the United States, reaching markets as far away as New York City, and a demand which began with Hawaiians who had come to the United States is gradually being extended to Americans, who have learned to like the dish. Poi is frequently used in Hawaiian hospitals in the diet of patients whose stomachs are too weak to digest other food, and the war interest in substitute foods is expected to lead to its wider introduction here.

Habits of Chimæræ

A VALUABLE and illuminating summary of what is known of the habits and migrations of Chimæræ off the Scandinavian coasts and the northern waters of our own shores is given by Prof. D'Arcy Thompson in the *Scottish Naturalist* for October. Though his survey includes two species, *Chimæra monstrosa* and *C. mirabilis*, his remarks are mainly concerned with the former species. Hitherto it has been generally supposed that this spawned only in deep water, but it is now shown to spawn off the Norwegian coasts in shallow water in winter-time, and to migrate to the depths during spring and summer. Prof. Thompson is disposed to regard these migrations as governed by temperature rather than by the search for food; for the species shows a partiality for cold or cool water, and while in general it finds this optimum temperature in the deeper waters outside the continental shelf, so also it finds it in winter, but then only in the shallow coastal waters of Norway. Many gaps, however, in our knowledge of these migrations yet remain to be filled; for it is pointed out that from its occurrence more or less all the year round off the south-west of Ireland we are precluded from supposing that the various localities where the species has been found lie in one continuous and regular route of migration. We cannot correlate what we know of it in Norway, in the northern North Sea, and off the Hebrides with what we know of it in the Bay of Biscay, the south-west of Ireland, and the Faröe Channel. It seems, on the whole, probable that in its more southern and more western habitats the habits of the species are different from those in the north; that it is here confined to deeper waters, but that it tends to resort periodically to still deeper parts of the ocean, where it chiefly spawns.—From *Nature*.

Building the concrete foundation and curbs in a recent construction for a modern road

A fine stretch of concrete asphalt road built to stand heavy traffic

The Bridge Theory as Applied to Roads

THE rapid development of motor truck traffic, a method of transportation that must be utilized to the full to meet a seriously congested freight condition growing out of the war, has led engineers to apply to roadbuilding the elementary principles governing bridge design.

The tremendous weight imposed by heavily loaded motor trucks operated at considerable speeds has made this necessary, as the strain upon leading highways will be increased as the traffic increases. For example, in Pennsylvania the use of certain types of motor trucks has increased almost 100 per cent. in the past year. That state now has under register some 18,000 solid-tired motor vehicles in addition to approximately 300,000 pneumatic-tired cars. The great volume of traffic imposed by these trucks and cars seeks the main roads, as is the case in all parts of the country.

The accompanying pictures of a road recently constructed on Staten Island, N. Y., illustrate the modern method of providing for both weight and volume of traffic.

The sub-base of the road is "bridged" by an indestructible base of Portland cement concrete cast with curbs. The result is a long and shallow trough of unyielding material, well protected and reinforced at the sides.

Between the curbs is laid a two-inch asphaltic concrete wearing surface, which not only protects the more brittle concrete from the abrasive action of solid tires, but serves to keep temperature and moisture conditions of the base sufficiently constant to prevent destructive expansion and contraction.

In brief, as in the case of a bridge, the concrete carries the weight of traffic while the function of the asphaltic surface is to resist traffic wear. When worn out after years of service, the surface can be replaced at about half the cost of the original road, thus providing virtually a new road at a very low price, while local repairs can be easily made at slight expense. In principle about the only difference between a bridge and the road described is that one is supported by abutments or piers while the other rests upon the ground.

How the Farmer Can Help

A. L. PORTER, secretary of the Western Retail Lumbermen's Association has inaugurated a campaign to help win the war, the particular object of which is to stimulate farmers to increase production, and this he suggests, while of the utmost importance at this time, is logical and sensible advice that should be adopted and followed even after the present pressure is relieved. The following extract gives the main points of his movement, which has met with wide approval:

"The plan I have suggested for a National Campaign in every town and hamlet for next spring has received favorable comments and commendations from practically all sources. The idea has been referred to as 'Home-Builders' week. This is a very poor name—it does not express the object at all. We must find a proper and expressive slogan for that campaign and use it.

"We are engaged in a great war. Our first and only duty is to our Allies and ourselves. We will produce ships, aeroplanes, ammunition, guns, men and equipment of all sorts; but after all, the all-absorbing question is an ample production of foodstuffs—meat and cereals. That should be the object of this great National Campaign.

"A campaign is needed to inject pep and enthusiasm, plus encouragement to the tillers of the soil of this country so that they will increase grains and cereals and meat 25 per cent. during 1918.

"There is no question about the demand and the price for these commodities. If the farmer will produce them, he already has the market and the demand coupled with a profitable price. That will give him the funds with which to meet his accounts payable on the books of the merchants of this country, to buy more Liberty Bonds and still have plenty left with which to buy building materials for the proper housing of his hogs, chickens, machinery, cattle, all livestock and the proper shelter for his produce.

"The first step in this campaign and the great idea therein is to enthuse the farmer to a point where he

Spreading the asphalt surface on the concrete foundation

will raise the crops and the livestock. Then he can readily see where he will have the funds with which to purchase the proper things to properly take care of his production.

"After the crops are gotten under way, then a campaign for properly taking care of them can follow.

"Think of the enormous waste in this country. Thousands of chickens die every year from exposure. That means an enormous loss and waste in meat and eggs. Thousands of hogs die every year from cholera and other diseases through exposure and improper care and feed. The same is true of cattle and all livestock.

"One hundred million dollars a year is wasted by the farmers of this country in not taking proper care of their farm machinery and tools.

"The thing to do now is to build the buildings we need with which to win the war, and these are buildings for the proper housing of livestock and foodstuffs; but, first of all, we must put on an energetic, active and enthusiastic campaign to see that these foodstuffs are produced. The livestock and foodstuffs already produced must be given proper care, as well as the crop that is to come."

Train Control

Automatic Brake Operation

THREE times already this year have the British Board of Trade Inspectors reported on the need for the automatic control of trains. When reporting upon the train smash at Oakley Junction, near Bedford, Colonel Pringle said that "the case is a further illustration of the necessity of some form of automatic train-control to safeguard neglect upon the part of enginemen properly to observe signals." Two further reports deal, respectively, with the collision between a goods train and a postal train ar Kirtlebridge, on the Caledonian Railway, and the collision between two passenger trains at Wigan on the London and Northwestern Railway. In the former case Colonel Pringle suggests again "the adoption of a system of automatic control of trains, whereby the continuous brake is applied when an engineman passes a fixed signal at danger." He points out that any such system should include provision for a full brake application at an actual stop signal, and preclude the possibility of a driver releasing the brake until after the train had come to a stand still. This view is entirely supported by Lieut.-Colonel Druit in his report on the Wigan disaster.

In the face of such reiterated expressions of expert opinion it is clear that the old laissez-faire policy will have to be abandoned. As long as it was merely a case of "cranky inventors" urging the need for the automatic control of trains no attention was given to the matter. But now that the Board of Trade officials are themselves taking up the same standpoint on this matter we may expect something to be done. That there are many technical difficulties in the way of the general adoption of automatic train control can be freely admitted, but they are now much less formidable than was the case before the railways came under the control of the State upon the outbreak of war. Then each company experimented independently, and systems were being evolved that were useless for through running purpose in that they operated only on one particular company's lines. It is obvious, especially now that there is so much inter-running of one company's engines over another company's lines—inter-running that will tend to increase still further in the future—that any system, to be really effective, must be universal throughout the country.

There are various systems that could be adopted, one of the best-known examples being that provided on the London Electric Railways, in which a "trip" automatically applies the brake if a signal at danger be passed. These trains, however, do not travel at speeds such as are attained by main-line steam trains, and the sudden application of the brake on a train running at, say, sixty miles an hour might be almost as disastrous as a collision. The kinetic energy stored up in an average express train running at sixty miles an hour is such that, with normal hand application of the brakes, a distance of no less than 1,000 feet is required to bring the train to a standstill. If the brakes were applied automatically with their full force instantly there would almost certainly be a derailment, while the passengers would inevitably be violently thrown from their seats and injured.

To get over this difficulty it might be arranged that, as the train approached the final danger signal, at the preceding warning signals the brakes could be applied with increasing intensity. This would, of course, necessitate a more complicated system of fixed ramps and of brake control than would be the case if there were only one final brake application provided for, but the difficulty should not be insurmountable.—*London Daily Telegraph.*

Production of High Temperature and Its Measurement*

A PAPER on the above subject was recently presented before the Faraday Society, London, by Dr. E. T. Northrup, of the Palmer Physical Laboratory, Princeton, N. J., a summary of which is reported in *Engineering* as follows:

The use of carbon as a resister was limited by the fact that carbon entered into combination with many elements at high temperature; even when direct contact between the carbon and material was prevented, reducing gases were generated which were, moreover, carriers of what he assumed to be particles of free carbon, so that tungsten, molybdenum and tantalum, *e.g.*, quickly became brittle in a carbonaceous atmosphere. Tungsten could serve as a resister, in the shape both of wire or ribbon or of a tube; the latter required a reducing atmosphere of hydrogen, but offered great possibilities. The resister furnace, especially as a melting furnace, unfortunately had a low thermal efficiency. Supposing copper were to be melted in a graphite crucible. The crucible would be placed within an alundum tube, which was outside-wound with nichrome wire, itself jacketed by a cylinder of a heat insulator of considerable wall-thickness. With this arrangement the heat generated in the wire had to travel through, say, 0.5 cm. of insulating material before reaching the copper, and through twenty times as much insulation before reaching the outer furnace wall. If the wire quickly attained 1,282 deg. C. (the maximum safe temperature), the heat gradient from wire to copper would first be of that order, and heat would flow twenty times more quickly to the copper than to the outer wall. The copper would soon melt, at 1,082 deg. C., and then that gradient would be reduced to 200 deg. and less, whilst the gradient to the outer wall remained as high as before. Thus the heat available for fusion became diminished to a small fraction of the heat generated in the nichrome. If the metal melted at the maximum temperature, the efficiency of melting would be zero. In the ideal furnace the heat should appear directly in the furnace walls, or, better still, in the substance to be heated, and should not be introduced from outside. That was possible in an induction furnace. The ordinary induction furnace interlinked an electric current and an iron magnetic circuit, however, so that the simplest form of crucible construction was not realizable. Owing to the different expansions of refractory material and metal it was not permissible to let the metal solidify in the furnace, and the furnace had to be started with preheated metal, which had to be removed before freezing. The induction furnace, moreover, was a step-down transformer with large magnetic leakage; it did not lend itself to special atmosphere or vacuum-working, and it did not admit of very high temperatures.

His own induction furnace dispensed with all magnetic interlinkage, and depended directly on the electromagnetic induction produced in the walls of the crucible or in its contents by sending high-frequency oscillating currents through a coil surrounding the crucible. When a condenser of capacity C was charged to V volts, potential energy was stored in the dielectric to the amount of ½ C V², and the discharge of the condenser released this energy as kinetic energy in the form of radiation (for radiotelegraphy) or heat. He thus utilized a Tesla coil arrangement in which the volts were transformed down and the current intensity was raised. His apparatus consisted of adjustable reactance, transformers, an entirely new type of discharge gap (silent and without moving parts, not described) and two banks of condensers, on a two-phase supply circuit of 60 cycles at 220 volts. The currents passed through 50 turns of the coil, surrounding the crucible at a sufficient distance to ensure both electric and heat insulation. A furnace of this type melted 45 lb. of brass in 35 minutes at an expenditure of 18 kw. His vacuum furnace contained a crucible of Acheson graphite, 14 cm. diameter, 18 cm. high, filled with tin or glass, this material being heated to 1,600 deg. C. in 40 minutes or 50 minutes; a vacuum of 1 cm. of mercury could be maintained; certain kinds of glass evolved gas, however, and turned frothy. Cylinders or crucibles of graphite of the dimensions stated could be heated to 1,600 deg. and cylinders of metal, etc., be heated to melting; platinum had not been heated yet, but the thermal efficiency was 60 per cent., and the furnaces operated on two-phase circuits both at full load and small loads with high efficiency. At the condenser terminals the tension was 5,400 volts or 7,200 volts; the frequency was the natural period of the circuit, 25,400 cycles or 12,500 cycles per second. The crucible was earthed and surrounded by a cylinder of quartz glass for electric insulation; the whole furnace was provided with a grounded metal cage for safety. When metal scrap was fused in magnesia crucibles, innumerable small arcs were formed between the metal particles; a layer of silox, 1 cm. in thickness, about the crucible, kept the inductor coil below red-heat when the crucible contents were above 1,400 deg. C.

Passing to temperature measurement, Dr. Northrup remarked that owing to the contamination of platinum-rhodium thermocouples by hot gases he had never been able to use these couples except intermittently at temperatures above the melting-point of nickel in a reducing atmosphere. Protected from access of

Fig. 1. PYROVOLTER CIRCUITS

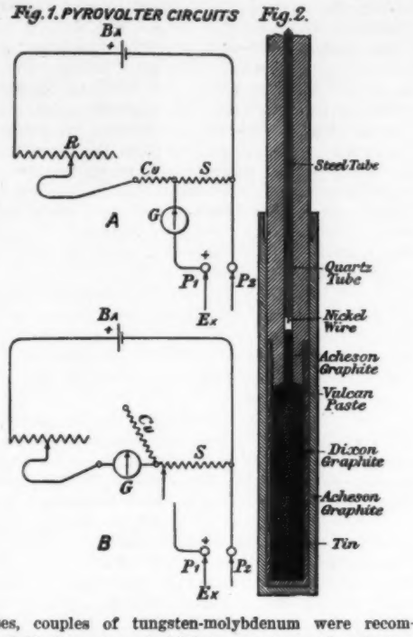

Fig. 2.

gases, couples of tungsten-molybdenum were recommendable for extremely high temperatures, though they gave only a feeble electromotive force. For works practice he had devised a robust, portable instrument, the Northrup pyrovolter, which operated on the potentiometer principle, but was not so delicate as a potentiometer. The pyrovolter resembled a portable galvanometer; Fig. 1 explains its construction. The current from the dry cell BA (Fig. 1A) passes through the rheostat R and the fixed resistances Cu (equal to the resistance of the copper coil of the moving element of the meter G) and S; S is of manganin and fitted with potential tapping-off connections; the current flowing through S is varied by adjusting R, so that a varying E. M. F. is aplied to the potential leads due to the drop of potential over the resistance S. The moving element of G is coupled in series with the unknown E. M. F. Ex through the binding screws P_1, P_2, across S, so that the meter serves as galvanometer to estalbish a balance between Ex and the drop across S. This adjustment is effected by turning a button (not marked) clockwise to increase the current; when balance has been attained the pointer rests over the line at the extreme end of the scale. Another button (not shown) is then pressed, and G is substituted for Cu (Fig. 1B below); as all these resistances are of copper, that substitution may be effected at all temperatures. The current through S is thus measured, and this current being proportional to the potential drop across S, which had been balanced against Ex, the E. M. F. Ex to be measured is read off on a deflection instrument. One of the advantages of this instrument was that the readings were independent of the temperature coefficient of the pyrovolter.

Another interesting novelty of Dr. Northrup's is his tin pyrometer, which utilizes the linear expansion of molten tin. Tin, melting at 232 deg. C., boiling at 2,270 deg. (Greenwood), did not, he had found, evaporate appreciably below 1,680 deg.—in a reducing atmosphere, we should add—was not contaminated by CO, and did not form a carbide with graphite. The electric resistance of liquid tin increased proportionately to the temperature, and the liquid metal thus afforded an extraordinarily large temperature range for resistance measurements (his tin resistometer) and for pyrometry. The tin of his tin pyrometer was contained in a bulb of close-grained graphite (Fig. 2) and expanded above 700 deg. C. into the graphite stem until it made contact with a nickel wire, which was provided with a quartz sheath and an outer steel tube. The nickel wire projected from the upper end of the pyrometer tube; it could be pulled up to variable heights, and the instrument was calibrated by determining the level of the tin column for two temperatures controlled by thermocouples, assuming the expansion of the tin in contact with graphite to remain regular up to 1,680 deg. at any rate. Like a mercury bulb, this pyrometer indicated not the temperature at a point, but the mean temperature over the space occupied by the bulb. To prevent slow oxidation of the graphite the bulb and stem were fitted with a tube of a carborundum composition; the clearance between the bulb and the jacket might be filled with molten tin or glass to keep out all gases. The instrument had not been in practical use yet; but molten tin, which could be obtained as pure as nitrogen, seemed to be a material of great possibilities for measurements of electric resistance and temperature above 1,550 deg. C.

The Potash Supply

IN an article in the *Manufacturers' Record* Mr. Richard K. Meade gives an account of what is being done in America to make up the deficiency in potash caused by the cutting off of supplies from Germany, and expresses the belief that the largest future source of cheap potash available in the United States is to be found in the cement and iron industries. In the year before the war the imports of potash from Germany represented some 250,000 tons of pure potash, while the production in the United States last year is estimated at only 10,000 tons.

It is remarked in the article that the loss of potash by volatillization from rotary cement kilns was pointed out as far back as 1903, and that from blast furnaces still earlier, but before 1914 nothing was done to collect the substance from either source. Some 10 years ago a dispute arose between the orange growers in South California and the cement mills over the question of the damage caused by the dust from the mills being deposited on the fruit trees, and to settle the matter the Riverside Portland Cement Company installed a process for precipitating the dust by the Cottrell electrical system. This process not only proved efficient as a dust-catching device, but also collected the potash with the dust. Most of the potash being water-soluble, it can be dissolved out of the dust by leaching with water. Before the war the raw materials used at Riverside were low in potash, and hence the amount volatilized was small, but after the outbreak of war the company found they could increase the output of potash from their kilns by the aid of feldspar, which can be used without injury to the cement. They also found that mixing fluorspar with the raw materials increased the amount of potash volatilizing to 90 per cent of the amount contained in the raw materials, as against 50 per cent volatilized under usual conditions. They next extracted the potash from the dust, and by crystallization obtained a potash salt containing at least 35 per cent of potash. The crust which collects in the stacks of the rotary cement kilns contains from 6 to 12 per cent of potash.

In the summer of last year the Security Cement and Lime Company put the Cottrell process into operation in order to catch all their kiln dust. They found that the addition of salt to their raw materials increased the yield of potash, and at present they are obtaining about 20 tons of dust a day, averaging 10 per cent of water-soluble potash. The Santa Cruz Portland Cement Company are recovering 700 pounds of potash daily from their kilns by a process of their own, and a number of other cement companies are installing or have installed Cottrell plants. When all these plants are in operation Mr. Meade estimates that they will yield about 10,000 tons of potash annually, and this amount could be very greatly increased by using some feldspar as a raw material.

As to potash from blast furnaces, the only iron company in America, so far as he is aware selling potash at present is the Bethlehem Steel Company. Up to the present only the dust which can be collected by means already at hand has been sold, the amount being estimated at about four per cent of the total potash liberated; but the chemist of the company believes that apparatus could easily be installed to catch at least 50 per cent of the potash now lost, and that the apparatus, so far from interfering with the operation of the plant, would benefit it through the better cleaning of the gas for the engines. It is estimated that of the potash volatilized in the blast furnaces the amount recoverable will average at least 10 pounds per ton of pig iron, so that with an annual production of 25,000,000 tons of pig iron the blast furnaces of the United States would produce say 125,000 tons of potash. Thus, by simply collecting the potash now lost, the American cement and iron industries could produce four-fifths of the amount formerly imported from Germany.

Improving the Automobile Engine

Laboratory Tests that Measure the Capability of the Finished Product

By R. M. Anderson

THERE was a time when barred doors and painted windows created about the laboratory a feeling of mystery to the uninitiated. At the present day we are safe in assuming that to go into minute and everyday laboratory routine would be too much like reading yesterday's paper, and shall as far as possible confine this paper to the justification of the large expense involved in the up-to-date equipment; at the same time showing the scope of this division of the automotive industry.

The laboratory measures the capability of a finished unit. The unit represents the assembly of the parts which the factory is to produce or is at present turning out. The laboratory finds out whether the functioning of these parts is up to the predetermined standard. The first run upon a new design is always watched with lively interest. The whole factory is concerned with this initial test.

We can safely say that the most important part of the entire factory product passes through the laboratory. Sometimes the "passing through" is not so rapid. The laboratory must then either justify the correctness of production or determine where the fault lies and correct it. This check upon the functioning of both design and production means security of business for the company.

Improvements in production without loss of quality are measured in careful tests. Even complications in production for purposes of raising the quality of an engine or bettering a competitor's product are shown to be justified by the results obtained in the laboratory.

For these reasons the data furnished by the laboratory must be unquestioned. To obtain accurate results and at the same time to control the disturbing conditions close attention and elaborate equipment are required. Yet the equipment should always be as simple as possible. How results are obtained is frequently as necessary to understand as the results themselves.

Instead of the special designs formerly thought necessary, testing equipment can be purchased today on the open market. As far as possible this standardized apparatus should be used, thus avoiding mental calculations in interpreting some other engineer's report.

The length of brake arm, revolution-counting device, gasoline and water metering methods, etc., should be standardized as far as possible. The addition of the aircraft, tractor and marine engines to the work of the laboratory will also require careful revision of tests in order to suit their widely differing needs.

The requirements in taking readings are increasing rapidly with our intensified war production. Frequent repetitions of long runs for which a large amount of data must be taken have demonstrated the value of military drill applied to testing. Each man has his duty at the switchboard, the scales, the thermometers, etc., and is held absolutely responsible for one detail. After a surprisingly short time the cooperation of these men in meeting the requirements of the test becomes automatic. The data from each man are collected at regular time intervals and the observations carefully inserted at the proper place in the report.

We have also found it of great assistance to plot a graphic log of the run upon a large blackboard. This is in full view of everyone and acts as a moving picture of the engine's performance. The run does not have to be finished before the engine has told its story. Fuel economy, oil consumption and power are observed while the engine is in action and in addition any variation is immediately detected.

The assistants will quickly respond to the training received from repeat runs and will become capable of taking dependable data. We believe that no run of importance should be undertaken until the general performance of the observers is as thoroughly tested out as is that of the engine. The attention of the engineer can then be concentrated upon the test itself, knowing that the chances for error are minimized.

For example, the man handling the dynamometer switchboard will almost anticipate the engineer's signals as regards the speeds and loads upon the engine being tested. This same man with his specialized familiarity of operation can best handle any unusual tests and will clearly understand what points require bringing out.

It is usually the lack of familiarity with a test that upsets the dependability of the result. Or it is equally true that the test is so like a preceding one that the mistake is natural. To avoid this, standardized or rather "familiarized" tests should be used as far as possible.

The method employed is something like this: Let us suppose that orders are received for testing a changed valve material. The foreman of the testing laboratory is referred to the record of a previous test, which has been used successfully to determine the endurance of valves. In this record is given the complete list of apparatus used, which he is to set up together with the engine, obtaining conditions exactly the same as those approved. The engine-speed, load, spark setting, water temperature and other conditions are also given, and when he is ready the run is started and the engineer notified. As long as no further notification is given the test is all right and the foreman assumes responsibility, keeping the engineer informed as to number of hours the test has been run and of any unusual indications of good or bad performance. Thus the engineer can determine the length of time necessary to test this valve.

If it is impossible to use a standardized test owing to lack of similarity, or to some new development, the foreman receives an order with the details carefully enumerated, following the procedure in standardized tests when such readings as water temperature are to be taken in a regular way. If this test is ever repeated it becomes a so-called standard. The foreman then has no excuse for lack of information about the test, and furthermore the report will be turned in with a careful record of what the set-up actually consisted.

As with the graphic log used for long runs we have also found that the use of a large blackboard bearing the captions and rulings of the curve sheets is of great value. The performance of the engine on its last test is plotted upon the blackboard. The values of "pounds pull" are written directly upon the curve where it intersects the values of revolutions per minute. Thus on the repeat run with the "hopeful" changes made we can compare quickly the scale readings with those secured before.

The blackboard can be used with equal effect for a generator test, when a comparison is to be made with what is known to be a good output. The blackboards are hung from the ceiling with counterbalance weights thus making possible their immediate use or removal.

Quite as important as the excellence and accuracy of the equipment is the decrease of the time element for set-ups. Weather conditions may be such that an unusual result is noted. To get a picture of this same phenomenon on another type of engine or with a proposed means to eliminate its effect requires fast work. Of course the ideal method is to have several dynamometers, but even then the extra engine may not always be set up waiting for the condition to arise.

So far as possible the minor measuring instruments should be carefully calibrated to read in units that will save unnecessary calculations later. Whenever calculations are unavoidable, the readings should be made in tenths of time intervals or quantities as the case may be.

Frequently it is necessary to check the actual fuel consumption before tests are made that do not involve the carbureter. A large quantity of gasoline must be weighed before accuracy is assurred. Many laboratories are consequently using a volume-measurement in place of weight. The volume can be constant and the time measured, or the volume can be variable and the time constant. For testing automobile engines the former method is preferred. Any arbitrary amount can be taken but for easy calculations a tenth of one gallon is convenient, this being governed,, of course, by the horsepower to be measured.

A container can be made of large glass tubing with both ends reduced in area. The small ends are provided for close readings. The tube is calibrated with a standard burette for whatever quantity is to be used, and the limits indicated at both ends. The lower end is connected with a three-way valve and piped up so that the engine does not have to be stopped during any of the operations necessary to measure the fixed quantity of fuel. Very accurate readings can be quickly made with this instrument.

For measuring the engine cooling-water venturi meters will be found invaluable. These simple instruments can be safely relied upon for accuracy within 2 or 3 per cent. and can be purchased complete with manometer calibrated for gallons, pounds or cubic feet per minute.

The serviceability of the venturi meter is illustrated by an engine test in which the load was varied but the speed maintained constant. The pump speed was a function of the engine speed, thus eliminating it as a variable so long as the engine speed was constant. The first engine used was entirely conventional in design; this was also true of the one used later as a check. The water-outlet temperature was kept as constant as it would be on any similar test and likewise every other disturbing element was accounted for.

While making the second test the reading of the manometer connected to the water venturi meter was noticeably higher than that for the first run. The main difference in the first and second runs was that the load in the latter was three times what it was in the first. This increased manometer-reading was also remarked when the load was still further increased to a maximum.

That the amount of water circulated was seemingly a function of the power led to further investigation. The particular engine tested was believed at fault, so after the run was concluded and the other purposes of this test accomplished it was decided to test a different make of engine. It was hoped thus to prove or disprove theories based upon the construction of the original unit. Particular attention was paid to duplicating everything except the variable reading upon the venturi meter, but the tests failed to show any results differing from those in the original engine. The rate of water circulation seemed to be also a function of the power in this second engine.

As a further check some trustworthy tests of a similar nature were looked up. One in particular showed a like result; namely, one made several years ago by Herbert Chase[1] on a Pierce-Arrow engine. This was remarkable for the fact that the water-pump capacity was carefully measured with the engine turned over by a dynamometer; the result therefore was not effected by any heat generated within the cylinders, as of course there was little if any heating of the water. Later with the engine run under its own power, it was clearly shown that the amount of water actually circulated had increased as compared with that required for the engine cold at the same speed. But let us not lose sight of what we started out with. This interesting disclosure, showing the value of minor instruments, was really the result of having a carefully calibrated water meter which read directly in pounds.

With carefully built instruments and the proper handling the laboratory is capable of writing a valuable history of its work. If history must repeat itself it should be along the line of design that has been proved sound and lasting.

The laboratory data should be constantly compared with actual results in service if the designer's success is to be based upon them. For this reason it is well to have similar subjects so arranged that service and laboratory reports will be filed together.

An engine for its particular field requires an exhaustive study of the conditions of that field. It is absurd to apply all the tests to a truck engine which are necessary for one to be used on an automobile. Similarly the tests upon an aircraft engine are far different from those upon a tractor engine.

Economy runs on automobile engines at wide-open throttle and full load give very little indication of the actual road economy. They do, however, materially assist the carbureter engineers to correct faults. But the average automobile is driven with a partly closed throttle under conditions quite different from full power performance. Our new specifications for testing

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* Prepared by Laboratory Testing Division, consisting of R. M. Anderson, Research Engineer, Packard Motor Car Company, O. C. Kreis, Chief Research Engineer, Continental Motors Corporation, and F. C. Wendland, Laboratory Engineer, Hudson Motor Car Company.

A paper delivered before the Detroit Section of the Society of Automotive Engineers and published in its Journal.

[1] S. A. E. Transactions, 1912, Part II, p. 140.

such engines reasonably insist upon various throttle openings throughout the speed range.

As an example the throttle openings for various road conditions on the level can be measured in degrees to correspond with the speed in miles per hour. These positions can then be used in the laboratory at engine speeds corresponding to car speeds and a fairly close approximation made of road economies. The same power data can be used with benefit to make the relations of the laboratory and the road still more valuable.

In order to be entirely familiar with the parts that make up the finished unit and to comprehend the design properly, it should be possible to test such parts as the cylinders, water-pumps and crankshafts adequately in the laboratory. This will frequently avoid a delay in taking parts some distance away in the factory when a special test is used in the production.

Accessories, such as generators, starters and ignition devices, purchased outside are of course tested before installation on the engine. It has been found of great assistance to plot the capacities of such accessories not only on the usual basis of revolutions per minute but also according to the corresponding miles per hour.

The value of the torque required in the starting motor to turn the engine at a given speed should be furnished the builders of the electrical instruments. This torque, however, is not the one that the dynamometer will register when connected to the flywheel. If the latter be used the large inertia of the armature will produce false results; the error increasing as the number of cylinders is decreased.

The test should be made through the transmission used with the starting-motor installation. The starting-motor pinion is fastened to the armature shaft of what is really a small high-speed dynamometer, thus enabling the torque required to be more accurately determined.

The cooling of engines of present-day construction is a problem requiring attention since the changes in fuels tend to upset previous standards.

Should the cooling system prove inadequate at the height of the season so as to interfere seriously with the car's service, there is but one choice for the manufacturer, namely, to correct it. To do this tests must be made to establish the causes of the difficulty.

The test is made as follows: the pump capacity is measured and the solidity of flow at all speeds analyzed; this is then compared with the radiator flow to take care of maximum speed at which car can be driven. If the radiator will not "flow" the requisite amount, the water piles up at the inlet and in time overflows. This rapidly empties the system, and boiling is a result. The baffle in the inlet to deflect the water rushing in to the sides of the tubes must be studied. Good distribution over the top area of the radiator will render effective the full frontal area of the cooling surface.

Tests must also be made to check the effectiveness of the fan in free air and also in the standard car-installation. The volume of air passing through radiator at the critical speed can be determined easily by driving the fan from a variable-speed electric motor, cutting a small space in the hood for the belt to pass through and coupling the front of the radiator shell to a flexible boot, which makes a tight connection with an air-measuring tube at the front of car. The advantage of increased louver-area and free space about an engine using a constant fan speed can be determined. Consideration must also be given to the additional air due to the velocity of the moving car, this being independent of the fan requirement.

On account of the engine a separate analysis is required of conditions existing between the radiator and the cylinder water-spaces. Improper shunting of the water will produce eddies and ineffective circulation. Too much water can be circulated at a point not requiring cooling, and vice versa. The design must be such as to eliminate foundry difficulties, for these are not evident from the outside and can be determined only by cutting a cross-section through the cylinder. Water should be circulated at a rate to corresond with car speeds and its flow studied for improvements.

When the various difficulties are "ironed" out the working of the actual engine must prove its effectiveness. Taking the low speed at which the car will negotiate hills of sufficient length to bring out heating troubles, various loads are applied so that a curve can be plotted showing the difference in inlet and outlet water temperatures. To obtain this the outlet temperature is held constant and the inlet varied. Though rough, this test will show whether the engine performance falls within the limit of previous practice. Should the difference be large, a correction should be made before proceeding with the final and more elaborate test.

In the final test two identical tanks are required. These are constructed in such a way that the outlet and inlet passages correspond to the pump intake and water outlet of the engine to be tested. These passages thus established will also fit the corresponding ones in any radiator adapted to this engine. Each tank should hold about 600 lb. of water. This includes necessary pipes, water-pump, etc., outside of the engine itself. The tanks and pipes are carefully insulated against heat loss by means of boiler covering.

The bottom pipe of the tank is directly connected to the pump intake of the engine; the upper pipe of the tank is connected to the cylinder-outlet passage of the engine. The tank is simply a reservoir in which sufficient water is stored so that the engine can run long enough for the proper readings to be taken before the water commences to boil.

The set-up of this tank with the radiator is about the same as with the engine with these exceptions: The lower outlet of the tank is connected to the suction side of a separately driven pump, and the water forced into the bottom of the radiator to be tested. The upper pipe of the tank is connected to the upper passage in the radiator. The direction of the flow of water through the radiator therefore is the reverse of what it is in actual practice. In addition to the separately driven pump, a fan is placed behind the radiator, as far as possible in the exact location used in the chassis. The pump and fan, however, are driven by separate electric motors, so that the rate of circulation of both water and air can be varied in order to measure their influence accurately.

The tank is filled with water to a point easily observed by reducing the top area to a small neck of about 6-in. diameter. This is marked to correspond with a known quantity of water in the system. The engine is then started and allowed to run at a fixed load and speed until constant heat conditions are obtained. As the engine runs the temperature of the water will obviously rise. This temperature, both when entering and leaving the cylinders, is read by thermometers. When the temperature of the water supplied to the engine rises to 110 deg. fahr. the stopwatch is started, and the time, in minutes and seconds, is noted for each 5 deg. rise until a temperature of 150 deg. is reached. This then represents a rise in temperature of 40 deg. for a measured interval of time. With the weight of water known, it is a simple matter to calculate the British thermal units that the water has absorbed from the engine and then to reduce them to British thermal units per minute.

The radiator tests are similarly conducted, except that the temperature of the circulating water should be above 150 deg. before starting. The stopwatch is started at the time when the average temperature in the tank drops to 150 deg. For each decrease of 5 deg. the time is noted until a temperature of 110 deg. is reached.

The fans, both in the engine and radiator tests, are driven at a speed that will circulate the volume of air corresponding to that due to the road velocity of car plus the fan displacement. If any variation is allowed the volume must be less, rather than greater, than this.

Both engine and radiator tests are run simultaneously, thus responding alike to any change in room temperature or to atmospheric variations. The interval of time should be equal for engine and radiator if the radiator is to handle the cooling efficiently for the given conditions, and this also helps to limit the variation of factors. Boiling results when the engine with a particular load requires less time for heating than the radiator requires to cool the same amount of water. In actual tests made by this method the average of results so far obtained check within about 3½ per cent.

Obviously, either test can be run without the other for comparison of engines or radiators. But this necessitates constant conditions of room temperature and has to be made with care. For general analysis of the engine heat-loss it is very valuable. This loss can be determined and used as a satisfactory record for basic comparisons. The British thermal unit per horsepower per minute gives the radiator manufacturer a figure of value in designing his product. Quite as important however are the pump flow in gallons per minute and the fan displacement in cubic feet of air per minute.

Some of the difficulties that must be guarded against in cooling tests are: high friction horsepower, insufficient radiating surface or radiator flow, leaks from combustion chamber to jacket space, incorrect spark manipulation, muffler back pressure, hood back pressure, carbureter setting and preignition from spark-plugs.

With the introduction of the highly developed present-day engine we have found changes necessary in many details. One of the developments has been in spark-plugs, their proper ability for carrying away heat and their location. About the first item to be observed in testing porcelain spark-plugs is the breakage. Porcelain is broken by sudden changes from heat to cold, especially in high-speed engines.

After the electrodes have been adjusted the plugs are installed in the engine, which is connected to a dynamometer. With the water at room temperature or less, the engine is started and the throttle quickly thrown wide open to let it reach its maximum speed. After about one minute at high speed the ignition switch is opened and while the engine is slowing down it should be noted if any preignition occurs. If upon examination the porcelains are not cracked, another run can be made at maximum torque with the engine still cold.

After these two runs, the heat test can be made. The temperature of the water should be brought close to the boiling point and tests made at low speed, wide-open throttle, at maximum torque, and at the highest speed of the engine.

During these tests leakage can be observed at the top and around the base of the porcelains. The top and the base of the porcelains can be given an oil bath to show up compression or explosion leaks. Usually porcelains are cracked during these tests. A cracked porcelain can be instantly recognized if the spark is retarded just enough to stop spark knocks; the cracked or broken porcelain will immediately cause preignition.

If on previous tests the porcelains withstand the hard abuse, tests for preignition can be made as follows: The engine being started and given full load at a low speed, the outlet water should be at about room temperature at the start and gradually increased with sufficient spark advance for the best torque of the engine. Tests should be made of at least five minutes, during which time one must be on the alert for knocks. If the engine develops spark knocks, the spark may be retarded a trifle; if knocking does not cease, open the ignition switch with the throttle wide open and observe whether the engine still fires with the switch open. If it does the firing is generally accompanied by sharp, hard knocks, and the engine will run for some time firing occasionally, which indicates bad preignition.

In making these spark-plug tests, it is assumed that the engine characteristics are known. The characteristics of a new engine require analysis for determining the limit of its power. A manifold change can produce surprising results. After a change of this nature had been made upon an engine the power was noticeably greater and the compression higher than with the small carbureter used in previous tests.

In other words, the breathing of the engine had been improved by supplying all cylinders with an equal, or more nearly equal volume. A manometer at each cylinder port is of great assistance to determine this. With a cylinder that is robbed of charge the depression will be higher than with those that are satisfied. The mixture balance can also be checked by running the engine with the exhaust manifold removed. Much piling up of raw gas can be eliminated by preventing its formation from hot-spot heating.

A New French Gun

In order to combat the German machine guns the French of late have introduced a new quick-firing cannon of such construction that it can be readily carried forward by attacking infantry, says the *United Service Gazette*. Thus the skirmishers are able to put enemy machine guns out of action by well directed shots from their 37-millimeter cannon, which they can carry along with them. The French "37" is a befitting companion to the famous "75," which has figured so prominently in the French campaigns to date. The smaller weapon has every feature of its larger brother, including quick firing breech mechanism, accurate sights and automatic recoil. Lying out on open ground, two men can fire up to 35 high-explosive shells per minute. The shells measure about 1½ inches in diameter, and the gun has a range well above a mile for accurate shooting. This odd little field piece can be readily taken apart and carried by six or eight men, and is available for use in advanced positions as well as in the open. It is a most workmanlike piece of armament for use under the conditions prevailing on the western front.

Photo from American Museum of Natural History, N. Y.

Haida Canoe and native Chiefs in regalia for the "Potlatch, "Museum of Natural History

Popularizing Anthropology

What Museums Are Doing to Make Science Attractive

By Edward Hale Brush

THE idea that anthropology and ethnology are studies for only a learned few was formerly held by the general public. But in recent years the museums have been making such study so attractive that he who runs is inclined to stop and read. And he may, even in the hurry of the ordinary American life, learn something in passing of the outline of the history and development of the race and perhaps this may tempt him to a closer scrutiny of the subject.

This is part of the general policy of making the museums places of resort and education for the masses rather than institutions whose privileges are mostly reserved for connoisseurs or scientific experts. In the case of ethnology and archaeology the fields of exploration and research have yielded such rich fruits in recent years that there is special reason for placing these results before the public so that they may be readily understood and appreciated. There is also the growing sentiment that relics of the aboriginal races of our own continent should be preserved with especial care and that the customs and folklore of such races, as well as the remnants of their dwelling places, should be kept from disappearing into oblivion.

There are two main aspects of the study of anthropology, one pertaining to living types of primitive man and the other to races of the past, no matter how far back into the dim and distant ages this research may go. Be it man dead and gone a hundred thousand years or man of the primitive type living today in remote corners of the earth, for one or the other the hunt has been proceeding with particular zest in the past few years and quite recently some exceedingly valuable finds have been made which add to our knowledge of what we call the human race. For it has been the human race since the epoch of the earliest well-authenticated relics. Such relics contain proof of remarkable resemblance between the men of 150,000 or even 200,000 years ago and those of today.

Not so very long ago all one could find in a museum to illustrate the subject of anthropology was cases of specimens collected from burial mounds or obtained from travels among wild tribes of men. However interesting to the student these might be they did not attract and fascinate the average person and in them alone there was little to lead a visitor on to further study and investigation of the really absorbing theme of the development and progress of the race.

The contrast to the former conditions is illustrated in some reproductions of aboriginal and primitive life recently installed in the Hall of Anthropology of the American Museum of Natural History, New York. Art has been effectively and ingeniously employed in the restorations of this and other museums and quite a new and boundless field has been developed in this way for mural painters, sculptors and devotees of various lines of art craftsmanship. First efforts along these lines may have been crude but better standards are being attained. This is exemplified in the groups mentioned which really deserve praise as works of art and are very life-like portrayals of the aboriginal peoples of the American southwest. They show them engaged in their customary vocations. A motion picture could scarcely be more graphic. Through the employment of both sculpture and painting an impression of reality is gained which is almost startling. One seems to see these Indians, who are of the Apache and Hopi groups, actually before one in life, weaving rugs, tarring baskets, building teepees, or engaged in other domestic tasks, there being no suggestion of warfare, since that has too often been overemphasized in portrayals of the American Indian. The sculptor of these groups is Mahonri M. Young and he worked in collaboration with a mural painter who has given especial study to aboriginal life, Howard McCormick. The skill shown in these groups results in distance being simulated in a surprising manner and the lighting is such as to give a warm sunny effect which seems like nature itself.

Maori warrior defying war gods in dance. Figure on a piece of jade in American Museum of Natural History, in hall showing cultures of South Pacific. By courtesy of the museum

In the Apache group a woman is in the foreground, tarring a basket under a summer habitation built of boughs. A naked youth in the middle distance is modeled with skill and there are other figures of children, women and warriors, with a background of mountains painted by Mr. McCormick. The Apache were chosen for this group as representing the nomad Indians of the Southwest. They make use of small, easily constructed houses which are deserted when the occasion arises. During the summer months they spend much time under flat-topped sunshades supported on forked posts which afford protection from the sun but permit free entrance of the cool breezes. They also construct dome-shaped houses and a woman is seen engaged upon making one in this group. The Hopi Indians are the subject of the other group by Mr. McCormick and Mr. Young and there is to be a third presenting a ceremony of the Navajo.

Artists and artisans of various orders of genius have been called on in the illustration and arrangement of the rare treasures which have been brought

Photo from American Museum of Natural History, N. Y.

Neanderthal man of La Chapelle aux-Saints estimated to have lived as long ago as 40,000 years. Restoration by J. H. McGregor, Department of Zoology, Columbia University

Pithecanthropus Erectus. Upright standing Ape man of Java. Restoration by J. H. McGregor. Head modelled on a restoration of the skull, of which only the skull cap and two teeth were found. Estimated antiquity 500,000 years

Photo from American Museum of Natural History, N. Y.

Type man of Cro-Magnon race. Estimated antiquity, 25,000 years. Restoration by J. H. McGregor

back by ethnologists and archaeologists in the expeditions sent out by the great American museums and universities and some European institutions to explore among primitive tribes and observe their ethnic peculiarities or excavate in lands where relics of ancient peoples are to be found. All such research throws light upon the evolution and history of the race from the primeval period down. Such discoveries as those of Prof. Vilhjalmar Stefanssohn in the Far North and such expeditions as those of Yale University and Amherst College in Latin America, of Rodman Wanamaker in the American Southwest and those to Australasia and the North Pacific under the auspices of the American Museum of Natural History, or of the Brooklyn Institute of Arts and Sciences to Alaska and New Mexico have done much not only to direct public attention to such subjects but to afford material for popularizing the study of ethnology. The discoveries that have been made in various lines of ethnological research will ultimately serve as a basis for constructing a history of the race for many ages prior to what we have been accustomed to consider the dawn of history and this great and wonderful story must be told so that the people can appreciate it, as they are now trying to do in the museums. Interest in the American aborigines is helping this movement and being helped by it. An instance is the institution of American Indian Day, May 13th, observed in 1916 for the first time by governmental proclamation. It reminds us of the Redmen and the many aspects of their character which are worthy of being remembered even though some barbaric occurrences connected with their relations with the whites are not pleasant to recall. Governor Charles S. Whitman of New York in his Indian Day proclamation invited "the attention of the citizens of the State of New York to the history, the social institutions of these people and especially to the present and future needs of the 5,000 Reservation Indians now resident in this State."

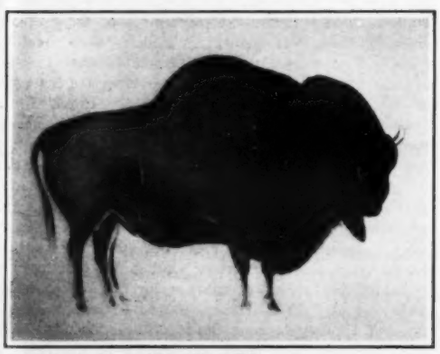

Photo by American Museum of Natural History, N. Y.

Art of the Cro-Magnon race. Reproduction of polychome rockpainting of bison, in cave at Dordogne, France

The State Museum at Albany has a splendid collection of the relics of the Six Nation Indians of New York, the League of the Iroquois. A recent issue of the Bulletin to the schools, published by the University of the State of New York, was devoted to this subject and it said:

"This Bulletin is devoted to the Indians of our State because we want the teachers and children to know the Indian as he was; to understand the extraordinary character of his native government, and to appreciate his decisive influence in the early history of New York. We wish all to know what is being done in the State Museum to perpetuate the memory of our remarkable aborigines. The soil of our State is scattered with relics of Indian occupation —arrowheads and spearheads, axes and other articles of stone, beads, pottery, etc. They are the remains of a vanished culture, and the State Museum desires to acquire and preserve everything of this kind to the end that there may be preserved a faithful picture of the unique political and social life of the 'Men of Always.'"

Photo by American Museum of Natural History, N. Y.

Rockpainting of reindeer in cavern at Dordogne, France. Reproduction in the American Museum of Natural History

The League of the Iroquois has now transferred its archives of wampum to the keeping of the State Museum. In the Museum halls are being erected a series of restorations designed to portray to the generations of today the Iroquois and their activities as

Hopi Indians as pictured by Mahonri Young and Howard McCormick, American Museum of Natural History

Photo by American Museum of Natural History, N. Y.

Apache group, American Museum of Natural History, by Mahonri Young and Howard McCormick

they were before the coming of the white men. One of these mural decorations presents a hunting scene among the Senecas. The background of the scene is a painting 55 feet long, picturing the shores of Canandaigua Lake, N. Y., and Genundewa, the sacred hill of the Senecas, and in the foreground is a family group busied with hunting, dressing of food, skiving of skins, etc. There will be six of these groups in the Iroquois Hall, all with backgrounds of historic scenes with foregrounds filled with life casts taken from the Iroquois of New York. It is perhaps the most elaborate restoration of this kind yet undertaken.

The Delaware Indians, who were of a stock closely related to the Iroquois, have been made the subject of some interesting restorations by Dwight Franklin in the Newark, N. J., Museum, which is in the territory over which the Delawares roamed. These show the bark lodges or "long houses," in which the Delawares lived, of the same type of dwelling as the Iroquois bark lodge, and scenes typical of the customs of the Delawares. By the use of both paintings and of figures and groups, modelled in wax or plaster and suitably costumed, very realistic representations are given which may be at the same time highly artistic. This is the case in the series of panels for the halls of ethnology of the American Museum of Natural History in New York by Edwin Willard Deming. Mr. Deming stands at the front as a painter of Indian subjects, having given his entire career since early manhood to efforts to interpret through artistic mediums the folklore and tribal customs of the Redmen. His mural decorations for the Natural History Museum are no doubt the most important works of the kind ever executed and increase very much the educational value of the ethnological collections in the halls which they adorn.

The Brooklyn Institute of Arts and Sciences has installed collections in its department of ethnology which give a vivid idea of the life of the Alaskan Indians and of the Zuni and other pueblo or cliff-dwelling red people of the American Southwest. Through them even the casual visitor may learn much of the industries of these people, the kind of habitations common among them, their religious customs, etc. There are models of the pueblos of New Mexico, collections illustrating the aboroginal life of Central and Northern California, past and present, and oil paintings of scenes along the southwestern border of the United States. There are decorative pictures representing the Haida Indian village of Massett with the adjacent landscape on Queen Charlotte Islands, British Columbia. The Alaskan Indians present a very picturesque and fascinating subject. Paintings by H. B. Judy of the Museum staff help to carry out the details of the picture presented and one sees the relics in their proper relation to this curious aboriginal life. Some of the totem poles are very fine specimens, several being house posts, used as supports within the dwelling, by Indians of Van Couver Island.

The Smithsonian Institution at Washington, D. C., has done a great deal through both its collections and the researches under its auspices to promote popular interest in this subject. Some of the results of the exploration and field work of the Institution among various races of mankind were recently shown in connection with the anthropological exhibits of the Panama-California Exposition at San Diego. Three years were required in the preparation of this exhibit under Dr. Ales Hrdlicka and five rooms in the Building of the Science of Man were filled. One room illustrated Human Evolution and contained a series of accurate, first-class casts of all the more important skeletal remains of authentic antiquity.

In passing it may be remarked that the Bureau of American Ethnology of the Smithsonian Institution has done much to preserve the music of the American aborigines, using for this purpose both musical scores and phonographic records. The phonograph has also been used in preserving linguistic records and has proved a valuable ally of the scientist. Even the motion-picture machine has been utilized in such work especially in recording upon the film the appearance of ceremonial rites.

There is a wealth of material illustrating anthropology in a popular way at the American Museum of Natural History. A single instance will show the growth of the idea. Twenty-five years ago, when the Museum was much smaller, visitors might have noticed suspended from the ceiling in the Heber R. Bishop collection a 60-foot Haida canoe. Not long since, with the view of popularizing the collection, this canoe was brought down from the ceiling, placed on the floor of a new exhibition room where Eskimo, Alaskan and Siberian cultures are shown, and gradually filled with figures in plaster of Indians of this region performing tribal rites. The figures are the work of Sigurd Neandross, Norwegian sculptor of ethnologic subjects, and with the masks, weapons and other accessories form a comprehensive symbolic group. In the foremost position is a Chilkat chief in full ceremonial dress, his followers being arrayed in regalia for the "potlatch," in which families gladly impoverish themselves in order that the dead may be honored, the emblem of the clan exalted, or the social standing of the tribe recognized.

Again, take the work of the same museum in making attractive and graphic the collection illustrating customs of the South Pacific. A foremost position in this collection is given a figure of a Maori warrior standing on a large piece of jade—said to be the largest ever obtained in a single piece—and defying the war gods in a grotesque and curious dance. In the same collection are fine specimens of the tattoed human heads—relics of ancestors, or of enemies conquered in battle—which the warrior lords of Maori families took delight in bringing out for feasts or other great occasions.

In furtherance of this same idea of adding attractiveness to the story of race development the authorities of the museum have recently installed a series of mural panels by Will S. Taylor in the hall devoted to cultures of the North Pacific. They hang like tapestries between the weathered totem poles and help to provide an atmosphere investing with life and reality the inanimate objects displayed. With glaciers or cool mountain shades as backgrounds we see the weavers, the carvers and the basket makers and canoe builders whose works are gathered in the hall. A decoration picturing the steaming and adornment of the Haida canoe is placed above the collection illustrating the customs of the Haida people, who occupy the country south of the Thinget, including the Queen Charlotte Islands, and another panel portrays the Chilkat blanket makers at work, this product being not only the emblem of the clan but an expression, in a sense, of its folklore. The series forms a splendid portrayal of the customs and handicraft of these simple people and gives an insight into their industrious characteristics. At the Metropolitan Museum similar ideas are being followed in the effort to educate the public respecting the life of antiquity. This was strikingly shown at the opening of the new department of Egyptian antiquities in which are displayed the fruits of the labor of the expedition which the museum had in the Land of the Pharaohs for several years under the direction of Albert M. Lythgoe, curator of Egyptian art. Some of these priceless relics carry one back to a period 4,000 years before the Christian era, to a time close to the Neo-Lithic age. It is not so long since people generally believed the earth to have been created about the time when, as these remains show, a comparatively complex culture had been developed in the Nile country, all of which is very significant as to the age of the race.

At the American Museum of Natural History there is a fine collection of human bones and implements from the banks of the Delaware River, near Trenton, N. J., bearing upon the question of the antiquity of man on the American continent. This collection was made by Ernest Volk under the direction of Prof. F. W. Putnam and in describing it the museum authorities say:

"The antiquity of man on the American continent is a mooted question. In the Old World there is an abundance of indisputable archaeological evidence found in caves and glacial deposits dating back through the geological time known as the Quaternary epoch, which began many thousands of years ago. Many alleged finds of implements and human bones have also been made in both North and South America in deposits regarded as of Quaternary and pre-Quaternary ages; but thus far the majority of these finds have been explained by good authorities as incidents, accidents, frauds or at best as the results of imperfect knowledge of the circumstances on which the antiquity of the specimens depended. There is, however, no inherent reason why evidence of a Quaternary man may not be found in the Western World. The exhibit in the case is perhaps the most convincing proof thus far advanced for the antiquity of man in America. . . There is no absolute proof that the gravel in which the bones were found was not redeposited by water since the glacial epoch. Hence the whole question of man's antiquity in America awaits further investigation. Few archaeologists are convinced by the facts presented but for the present it may be at least regarded as entirely probable that man did live in the Ohio and Delaware valleys amid different faunae from those now existing and at the close of the Ice Age, which ended the Quaternary epoch about 10,000 to 15,000 years ago."

The work of the Yale ethnological expedition in Peru affords reason for belief that rich finds bearing on the subject will be made, for not only have these investigators uncovered many relics throwing light on the period of the Incas but they have secured traces, as they believe, of men who lived in South America as long ago as the glacial epoch. The whole question is inseparably connected with that of the age of the race as a whole. It is only in recent years that the general public, whatever the views of scientists, has come to realize the great age of the race and what a slow process it has been to develop it to the present stage. With the Garden of Eden eliminated as a starting point, by well-informed theologians as well as ethnologists, and some weird, primeval yet human creature who lived some half million years ago substituted as the first man of whom we can find undoubted relics, the problem of building up the historic story is much altered from what it was when 6,000 years was commonly accepted as the age of the race. It is here that the students of ethnology who go among the primitive tribes of today and bring back the fruits of their study to the museums and galleries aid in filling in the details which picture to us how the men of the far-distant ages, even hundreds of thousands of years ago, must have lived. The aid of the geologists and paleontologists is an essential factor, also, in such research. Thus we learn from geology of the connection of the British Isles with the European continent in glacial times, permitting free migration of animal life and human culture from the land to the south so that the Lower Palaeolithic peoples wandered at will from the Valley of the Somme to the Valley of the Thames, interchanging their weapons and inventions.

Some extremely important finds bearing on the story of prehistoric man have taken place within the past ten or fifteen years—some of the most important within the past five years—and the museums are just beginning to be able to present the results of these discoveries by means of paintings, models, casts, restorations and other mediums easy of comprehension by the average visitor. Among these discoveries are the relics of the art of man of 25,000 years ago found in the caves of the Pyrenees. The American Museum of Natural History is now engaged in installing exhibits illustrating these discoveries, which reveal the artistic achievements of men who lived and worked and aspired in Europe in the glacial epoch. Even men of science had scarcely supposed until these discoveries were made that the men of 25,000 years azo possessed much taste for art or skill in its achievement, certainly not such attainments as these astonishing finds reveal. Prof. Henry Fairfield Osborn of the Natural History Museum and of Columbia University has described them most graphically in his now famous work, "Men of the Old Stone Age," as well as in various publications of the Museum. In the preface to his most recent work he tells us: "This Palaeolithic tour of three weeks (among the caves of the Pyrenees) made a very profound impression, namely, of the very early evolution of the spirit of man and of the close relation between early human environment and industry and the development of mind, of the remote antiquity of the human powers of observation, of discovery, and of invention. It appears that men with faculties and powers like our own, but in the infancy of education, and tradition were living in this region of Europe at least 25,000 years ago. Back of these intelligent races were others, also of eastern origin but in earlier stages of mental development, all pointing to the very remote ancestry of man from earlier mental and physical stages. Another great impression from the region is that it is the oldest center of human habitation of which we have a complete, unbroken record of continuous residence from a period as remote as 100,000 years, corresponding with the dawn of human culture, to the hamlets of the modern peasant of France, A. D. 1915. In contrast Egyptian, Aegean and Mesopotamian civilizations appear as of yesterday."

According to Prof. Osborn the history of these men of superior intelligence who were "gifted with a strong artistic sense" extends "from the close of the glacial age, 25,000 to 20,000 years ago, to the arrival of Neolithic men, perhaps 10,000 years ago. There was a crude form of religion, the dead were reverently buried, society was broken up into groups according

to special talents, there were undoubtedly chiefs or rulers, hunters, flint makers and especially sculptors and painters, whose art exceeds that of any other primitive men, ancient or modern." Prof. Clark Wissler says, speaking of the significance of these cultures: "The universal human was there in that dim, remote past, as it is with us still."

These ancient Europeans belonged to what has been called the Cro-Magnon race by the archaeologists. Back of them in Europe were the Neanderthals, so-called from the valley in Germany where the first find of skeletal remains of this race was made fifty years ago, about the time that Darwin's theories of origin of species were first attracting attention. Many relics of this race have since been found in Western Europe. They were much more primitive than the Cro-Magnons but within a very few years relics of men of even more archaic type than the Neanderthals have been uncovered. In 1907 a human jaw was found in the Mauer sands near Heidelberg by Schoetensack. The discoverer referred the Heidelberg man to the First Interglacial stage. Osborn places it in the second, estimated at 250,000 years ago. The circumstances of the find indicate how such things sometimes occur. It was made at a depth of 79 feet from the upper surface of a high bluff in ancient river sands which had long been known to yield very old mammalian fauna and for years the workmen had been instructed to keep a sharp lookout for human remains. Thus was made a discovery of momentous importance.

In 1912 and 1913—some parts being picked up at one time and some at another—Charles Dawson, the eminent geologist and associates, found the Piltdown skull, at Piltdown, Sussex, Eng., "one of the most important and significant discoveries in the whole history of anthropology." The Piltdown man is known as Eoanthropus, the "dawn man," and Prof. Osborn says is "the most ancient human type in which the form of the head and size of the brain are known." Study of the characteristics of Piltdown man is aided at the American Museum of Natural History not only by restorations of the skull and facial conformation but by cases containing flint implements illustrating the culture type of the period. In the strata where the Piltdown skull was found were also discovered primitive tools. They indicate that it was the dawn stage of human invention.

The Trinil race of Java has been so named from the discovery near Trinil in Central Java in 1891 by a Dutch army surgeon, Eugen Dubois, of a skull and thigh bone and two molars believed to belong to an apeman, Pithecanthropus Erectus, that is, upright-standing apeman. Anatomists have concluded from the form of this thighbone that "this fossil creature had the same upright posture as man and likewise walked on two legs," and "from a study of the femur and skull it follows with certainty that this fossil cannot be classified as simian." The length of time ago that this creature is supposed to have lived is placed at about half a million years. The most authoritative geological research refers the remains to early Pleistocene times rather than Pliocene as Dubois, the Dutch discoverer, supposed. This is important because it might admit of a variation of several hundred thousand years in the age of the relics. It may increase the popular interest to add that this specimen of the Trinil race, being of erect posture, possessed no tail.

We may gain many hints about the characteristics of these early men, especially the Neanderthals and Cro-Magnons, from the implements they left as well as from the conformation of their skeletal remains. Study of the tools of the Old Stone Age—which should be distinguished from the New Stone Age—is a science in itself and its results throw much light on the environment and life of the men of the most ancient races. Similar study gives us some idea of the time when fire was discovered, or put to domestic use, and the family or tribal hearthstone set up. These tools indicate to us also something about the garb in which these primeval men and women arrayed themselves. From such study, for instance, we learn that the Neanderthal man of Chapelle-aux-Saints, discovered in 1908, and inhabiting Central France in times of what is known as the Mousterian culture, had reached a considerable degree of intelligence. His antiquity is estimated at from 25,000 to 40,000 years. The fact that some, at least, of these Neanderthal men practiced ceremonial burial indicates the dawn of a belief in some kind of a future existence.

Painters have sought to depict the scenes of the Stone Age and even the novelists have recently been taking characters from it. While it is not possible as yet to reconstruct in much detail the life of the times in which the earliest races like those of Heidelberg and Piltdown lived, no doubt the museums by employing the same methods used in depicting the customs of the primitive men of today will soon be giving us pictures in outline of the ways of more ancient man. Already something in that direction has been attempted. One such effort is that of Mr. Franklin, sculptor of the Delaware Indian restorations already mentioned, who has recently completed a restoration of cave people of Neanderthal type. A man and woman stand at the mouth of their cave. They have been disturbed at their meal within by the approach of a bear. The man grasps a stout weapon. The cave woman, a baby in one arm, is reaching out quickly in the other for a spear. The cave bear Mr. Franklin believes to have been like the Alaskan grizzly, and he has so modeled the beast. Besides the fashioning of stone weapons the man knew how to make a fire. Its light is seen from within the cave.

In restorations of this type the imagination, of course, must be allowed some play. But in restorations showing the appearance of primeval man, in features and form, the actual remains are faithfully followed. Restorations of the men of Cro-Magnon, Neanderthal, Heidelberg, Piltdown and Trinil have been very carefully made for the American Museum of Natural History by Prof. J. H. McGregor, and these enable us to compare the relative progress made by the different human types. Among the first to make a really scientific effort at plastic reproduction of primeval man was Richard Swan Lull, Ph. D., professor of vertebrate paleontology at Yale and associate curator of the Peabody Museum of that University. He studied the finds of Spy, Galley-hill, and Chapelle-aux-Saints and sought to put in plastic form his idea of what the man of perhaps 150,000 years ago was like. In the *American Journal of Science* he says of this reproduction:

"The model is based mainly upon what is known as the 'Man of Spy No I,' one of two specimens found at Spy in Belgium, of which the Peabody Museum contains plaster casts. My conception of Homo Primogenius is that of a man of low stature, standing only three feet five inches in height, but of great physical prowess, as indicated by the robustness of the limb bones and especially of their articular ends. The great paunch of the higher anthropoid apes, which are almost exclusively vegetarians, is lacking, and in its place is shown the clean-cut athletic form of torso such as one sees in the typical North American Indians, for I imagine food conditions were about the same. This type dwelt in Europe before the last glacial period, estimated at from 100,000 to 200,000 years ago, and continued for a long period of time, for his remains are found entombed successively with both cold and warm climate animals. * * * The 'Man of Spy,' while showing more pithecoid characters than his successors, was nevertheless eminently human, representing as he does the type just preceding modern man and one far removed from a true ape-like ancestry. In the popular conception 'pre-historic man should be goriloid, or at any rate, distinctly simian. Against this misconception the model stands as silent protest.'

The New Zeppelins*

THE capture of a super-Zeppelin with all its crew and papers has thrown some interesting light on the progress made by German airships since the days not so very long before the war when a German dirigible paid an accidental visit to Lunéville, and was carefully overhauled by the French air experts before it returned home.

The Zeppelins that came to an untimely end the other day in France are believed to have been of the latest type. Six hundred and forty-three feet in length, their total height is 114 feet, and their eighteen balloons enclosed inside the aluminum framework contain 55,000 cubic mètres (about 1,060,000 cubic feet) of hydrogen. In other words, they can raise 55 tons from the ground.

Their aluminium structure weighs between ten and twelve tons, and to this burden must be added five Maybach motors, each of 240 horse-power, the cars and balloons, the crew, petrol, ballast, and the thousand and one appliances necessary for an aerial voyage.

Allowance being made for all these encumbrances, just two and a half tons at the very most remain for explosives, if they are to be dropped on England.

The amount of bombs that can be carried depends, of course, first on the amount of petrol that must be carried to enable the airship to reach its destination and return; and, secondly, on the height at which the voyage is to be made. If it is to fly at a great altitude much ballast must be carried and the weight of bombs proportionately decreased.

The Germans have learned by bitter experience that if they intend to drop bombs on England without excessive risk from guns and aeroplanes they must navigate at a very great height, and their Zeppelins are built with a view to flying at between 16,000 and 20,000 feet.

At such an altitude they reckon that they should be reasonably safe both against shells and heavier-than-air craft. As a matter of fact, there appears to be some slight error in their calculations, since the other day one Zeppelin was brought down from a height of over 16,000 feet.

The enemy has overcome the vital difficulty of steering when the earth is out of sight by wireless telegraphy. The airship sends out a wireless message, which is received by the German land stations, and as soon as they have determined the direction from which the wireless waves come they can easily arrive at the exact position of the airship and tell it where it is.

The other night the German airships had to struggle against exceptional atmospheric conditions. Take the log of the captured airship. It started out with a gentle West wind that impeded its progress but little, and promised to waft it back most conveniently if anything went wrong. But, all unknown to the enemy, a depression was working up in the Mediterranean. On their journey the wind at a high altitude suddenly veered north and blew with great violence. It was a wind of about 80 feet a second, or about 50 miles an hour.

The Zeppelin, with all its motors working at full power, could travel at rather more than 60 miles an hour, so that if the pilot had been aware of the change of wind he could have gone back to Germany without excessive difficulty. The north wind was not directly contrary, so that he would only have had to make allowance for it in steering his course.

But it so happened that the pilot of the airship in question had no idea of what was happening. The earth was covered with a thick mist, and he had no fixed point outside the balloon to show him that he was being carried swiftly southwards. When he had dropped his bombs he had only one idea—to rise as high as he possibly could to get out of the reach of aeroplanes and guns. So he went up to a height of no less than 22,000 feet. At such an altitude the cold was intense. The temperature fell to over 30 degrees below zero (Fahrenheit). The crew suffered terribly, and, to make things worse, as a result of the excessive cold two motors broke down, including the motor that worked the wireless.

Thenceforward, there was no question of steering a course. The pilot, of course, tried to make for Germany, but, all unawares, he was being drifted southwards by the wind at the rate of 50 miles an hour. At length he let out gas and came down, hoping to find himself above Holland. What he found was a squadron of French aeroplanes waiting for him over Bourbonne-les-Baines. The whole crew was bewildered by the terrible cold to which it had been exposed, and had no fight left in it. The airship's armament was almost negligible, only two machine-guns. The result was that the dirigible and its crew were captured.

It has been said that the Zeppelin carries five motors. Three of these motors are in the forward and two lateral cars, while the stern car has two motors. Each car has only one propeller in the stern. The two motors of the stern car only work simultaneously in case of grave necessity. If they are both geared up to the propeller the balloon is under forced draught, with a speed of about 60 miles an hour. As a rule, only four motors are working, and the fifth is in reserve.

The balloon commander is in the forward car, with the greater part of the crew. It was this car that was carried away by the trees on which the Zeppelin landed at Dammartin. The total crew for short raids is twenty-two, for long raids eighteen.

A supplementary statement says:

On the night of the raid the Zeppelins, steering at a height of 15,000 feet and afraid to descend to a lower altitude, found themselves caught in a violent and bitterly cold northerly gale. The wireless directives went astray or arrived in undecipherable shape, and the airships, soon after reaching the English coast, lost their bearings.

* From the *Morning Post*, London.

A New Heliograph

For Securing More Accurate Records

By Dr. J. Dupaigne

METEOROLOGY and climatology, like many other sciences, demand a progressive improvement in their instruments in the direction of greater precision. Thermic, electric, and barometric measures are never entirely satisfactory, and conscientious observers carry approximations as far as possible.

The measurement of the duration of insolation (and of its corollary, nebulosity), though generally believed to be very precise, is in reality still too crudely approximate, because of the instruments employed.

Impressed by this inferiority, I devised in 1913 a heliograph of sufficiently great precision, whose construction was confided to M. Richard (Figs. 1 and 2). On April 16, 1914, it was exhibited before the Congress of Thalassotherapy at Cannes, at sessions where a number of foreign scientists were present—German, Austrian, Swiss and others; it was then shown on July 7, 1914 before the Société Météorologique de France through the courtesy of M. Dongier. The minutes and bulletins of these gatherings have not as yet been published and perhaps will not be until after the war.

But a very similar instrument, which corresponds exactly to my own in principle, has just been officially adopted at Zurich by the Central Bureau and recommended to all the Swiss observatories, in 1916. It is not unimportant, at the present time, to defend the French origin of a scientific instrument against foreign claims.

In order to obtain good results, I deliberately renounced the attempt to measure intensity, which in all known instruments is much too vague and conventional under any sort of measurement, even approximate, and which greatly interfere with the exactitude of the instruments. It is preferable not to try to obtain it except with a truly actinometric device, and to require from a heliograph the measurement of duration alone.

This is the principle of the system: An optical image of the sun, punctiform in reality, is given by an orientable objective with a very short focus. It is moved by clockwork over photographic paper, whereon it imprints a linear tracing. In the model made for me by M. Richard the focal length is 17 millimeters. In consequence, the diameter of the image, measuring 0.158 millimeters, is assimilable to the point. In its displacement this luminous point traces a line which, by reason of lateral diffusion upon the paper, is more or less coarse, according to the amount of light, but always remains clearly defined as long as the sun is visible, even with a very feeble brilliancy. The points where the tracing is interrupted or resumed have the aspect of the ends of a line drawn with a well-sharpened pencil.

In order to be always oriented towards the sun, the objective is in some sort mounted on an equatorial. A rotation in 24 hours is effected by clockwork movement around an axis A A (Figs. 3 and 4) parallel to the axis of the earth. For the declination the objective bearing telescope is inserted upon a curved band of metal (S) in a segment of the cylinder, which can be moved along a slide in a meridian plane, following an arc of a circle whose center is at the focal point F, on the surface of the sensitive paper. The slide is graduated in degrees, but could be marked off in months and days.

The optical system has been mounted on an apparatus already constructed by M. Richard for his "*sunshine*" (daily) and that of M. Eiffel (weekly). A cylinder, B B, carried on the axles, A A, and closed by a lid, forms a dark chamber. The optical apparatus L S, described above, is fastened at the middle height of a screw, V. A clock movement placed at H H causes the cylinder to revolve by means of the pinions. P P, in the direction of the apparent movement of the sky. A second cylinder, T T, concentric with the first and held without rotation by the axles, carries the sensitive paper. If it is fixed it constitutes the daily apparatus, and the paper is changed every evening. If it is moved longitudinally from T to T′ by means of the screw V, sliding along the guides, G G, it constitutes the seven-day apparatus, within which seven daily graphics are found, superposed at the end of each week, which greatly simplifies the work.

Since the drum T T has a diameter of 105 millimeters, an hour is represented on the graph by a length of 13.75 millimeters, a space which is easily divisible, and in which even the minute is perceptible (0.23 min.).

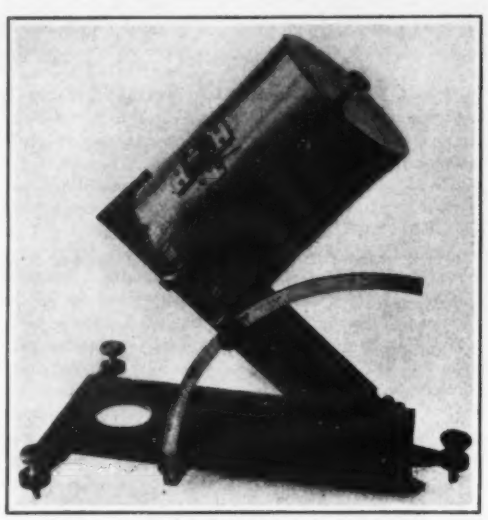

Fig. 1.—Precision heliograph invented by Dr. Dupaigne and constructed by Jules Richard

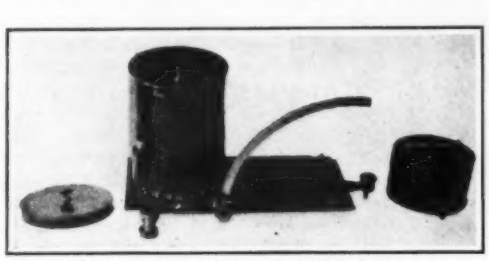

Fig. 2.—Another view of the instrument

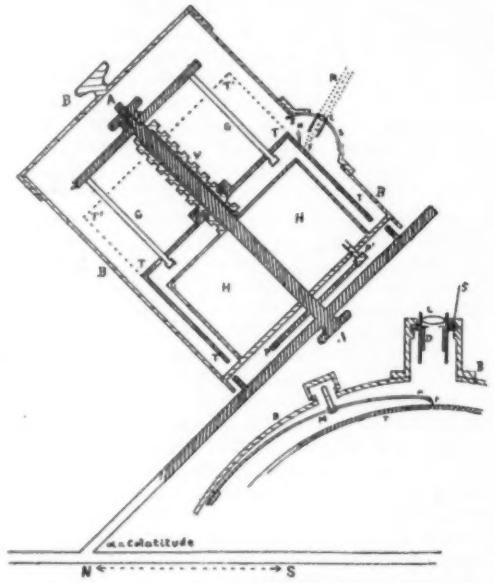

Fig. 3.—Diagrammatic section of Dr. Dupaigne's heliograph: Fig. 4.—Cross section of Fig. 3.

AA axis of rotation, paralled to the axis of the earth. BB closed cylinder carrying optical apparatus, and revolved by clock movement. HH and pinions PP′: L telescope carrying objective. F focus of lens where rays R. converge. S S segment of cylinder carrying the telescope for following the declination. T T drum carrying the photographic paper, and moved in 7 days from T′ to T along guide GG by screw V. N pen for marking the hours, and operated at will by lever M.

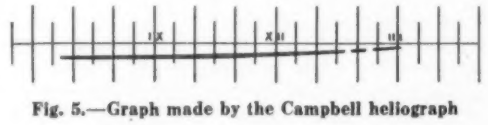

Fig. 5.—Graph made by the Campbell heliograph

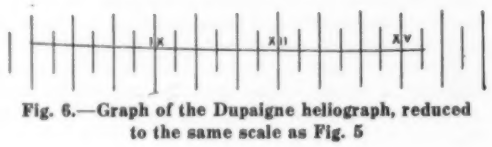

Fig. 6.—Graph of the Dupaigne heliograph, reduced to the same scale as Fig. 5

Any degree of precision desired may be attained by simply increasing the diameter.

For reading the hours of insolation I decided upon the following device. A pen, N, whose point is above the focal point F and near it, makes a vertical mark every hour upon the same generatrix. But possibly there may be errors in setting the hour and variations in the clock movement. To remedy these the observer can, by means of the lever M, lower the pen and make a mark in the graph, at the same time controling the time by his watch. With the seven-day apparatus it is sufficient to perform this operation twice a week; for example, when the paper is changed. An interpolation is exact for the other days. This mark makes it possible afterwards to place the graph at its true hour, either with reference to automatic horary marks, or better, by superposing upon the graph a scale engraved on glass, with the hours and their subdivisions.

The totalization, the most important operation, is made either directly, on days when the isolation is continuous, or, most often, by prolongation upon a strip of paper by juxtaposition of fragments of the graph. Days when insolation is very intermittent will demonstrate the superior precision of this heliograph over its predecessors, whose margin of inexactitude, for each interruption, varies between a few minutes and more than half an hour (Figs. 5 and 6).

Moreover, it is the only one that permits the elimination or the preservation, at will, of the hours when the sun is visible, only more or less dimly, through light clouds. In this case the image not being clearly defined, the line of the graph is coarser, with blurred edges.

Ferro-prussiate blue paper is the most convenient to employ, because of the absence of manipulation; it should be very fresh. When one has time to make use of a photographic laboratory the papers made with salts of silver are easy to find and, particularly, to keep. To regulate the illumination of the objective a different diaphragm, D, is provided for each of these papers.—*L'Astronomie.*

Vegetable Hair Palms in Madagascar

THE substance known as piassava or vegetable hair, is produced by the Vonitra palms of which a number of species grow in Madagascar. One of these is the *Vonitra Thouarsiana*, but M. Henri Tumelle mentions another palm tree or the *V. Utilis*, and it is a larger tree than the first mentioned. These palm trees are found principally in the east region of Madagascar and can be called on for a good amount of vegetable hair which serves like horse hair and others for numerous uses.

Mowra Flower

AN industrial product of considerable value can be obtained from the state of Hyderabad in the shape of the Mowra flower, and it is manufactured into products of commercial utility. The mowra tree abounds in the forests and open country in this region, and during the hot weather the flowers drop off the tree and are gathered and dried to the consistency of raisins. Hitherto they had been utilized for liquor alone. On the average some twenty-five thousand tons are gathered annually, of which about ten thousand tons are used for liquor and the balance is run to waste. It has been discovered that it is possible to make sugar, motor spirits and several other valuable products out of this material. In addition to sugar, the flower contains acetic acid and a certain amount of acetone which is one of the principal ingredients of cordite. At present the manufacture of cordite in India is carried on with acetone imported from Canada where it is produced from wood which contains only one per cent of acetone. It is observed that it is easier to manufacture from the mowra flowers than from wood and that there is no wholesale destruction as in the case of wood. It appears that the Government of India has purchased a large quantity of mowra from Hyderabad for use in the acetone factory at Nasik. Another fact which promises to be of great economic importance is that, with suitable additions, mowra spirit can be used with success as a substitute for gasoline as a source of power for internal combustion engines, especially in motor cars. It is stated that several kinds of motor cars have been run on a spirit prepared from mowra at half the cost of petrol and that 100,000 gallons of such spirits can be manufactured from 1,500 tons of mowra.

Recent Progress in Pyrometry*

New Instruments Now Necessary in Manufacturing

DURING the past five years, which is the period intended to be covered by the present paper, considerable advances have been made in the production of instruments for the measurement of high temperatures. Much valuable work in this direction has been carried out at the National Physical Laboratory in this country, and at the United States Bureau of Standards; and the manufacturers of pyrometers, chiefly in Britain and America, have introduced many new instruments for scientific and industrial purposes. Owing to the claims of atomic and molecular physics, the subject of pyrometry has not received that attention from physicists in general to which it is entitled by its industrial importance. The progress made in various directions may conveniently be considered under separate headings.

STANDARDS OF TEMPERATURE.

Various investigations of fixed points have confirmed, or at the most slightly modified, previously accepted figures. Up to the highest reading obtainable on the gas scale (1550° C.), the standards now in use appear to be well established; and beyond this the melting-point of platinum, as deduced by several different methods, is now accepted as 1755° C. This is a useful fixed point for the calibration of high-reading pyrometers.

The United States Bureau of Standards now issues materials of certified fixed points for the calibration of pyrometers. This procedure might with advantage be followed by our own National Physical Laboratory, so as to enable the indications of pyrometers to be checked from time to time by the user. If accompanied by instructions for use, a correct result would be insured, and the danger of error resulting from the employment of materials of doubtful purity eliminated.

THERMO-ELECTRIC PYROMETERS.

One of the chief features of recent years has been the extension of the use of base-metal junctions in place of platinum and platinum alloys. Suitable base-metal couples develop a relatively high E.M.F., and enable a strong and cheap indicator to be used in place of the sensitive instrument required for couples of the platinum series. Most makers now furnish iron-constantan pyrometers, which may be used up to 900° C. R. W. Paul employs two iron-nickel alloys of different composition which will register 1000° C.; whilst the Foster Instrument Company use two nickel-chrominum alloys, capable of reading to 1200° C. in continuous use, and to 1300° C. for occasional observations. For temperatures below 700° C. copper-constantan junctions are much used, as, for example, in pyrometers for superheated steam. Various other base-metal couples are in use.

The trustworthiness of base-metal junctions has been called into question by Kowalke (Transactions of the American Electrochemical Society, vols. xxiv. (1913) and xxvi. (1914).) Trials made on junctions of this type, as supplied by American makers, showed changes in calibration on heating for twenty-four hours ranging from 20° C. to 130° C., the higher figure being obtained at temperatures of 1000° C. The results showed the necessity of "ageing" the junctions by prolonged heating at the maximum temperature prior to calibration. Experience with British-made junctions shows that large errors of this nature do not occur, owing to a careful choice of materials and suitable treatment before calibrating.

C. C. Bidwell (*Physical Review*, June, 1914) has shown that a junction of carbon and graphite may be used to read temperatures as high as 2000° C. Previous heating to this temperature is necessary before calibrating in order to expel volatile matter. This junction gives promise of a valuable extension of the range of thermo-electric pyrometers, and may find industrial applications.

Materials for protecting junctions from the corrosive action of furnace gases have been added to by the introduction of alundum (oxide of aluminium), which melts at 2050° C.; a material known as "silit," which has a carborundum basis; and "silfrax," a substance resembling carborundum. All these materials are brittle, and therefore will not stand rough usage. As a protection for junctions used to read the temperature of molten brass or bronze, a tube of molybdenum has proved successful, as this metal is a good conductor of heat and is not acted on by the molten alloy.

Indicators for thermo-electric pyrometers have been improved in details by the various makers, resulting in greater trustworthiness. A new departure in commercial indicators has been made by the Leeds and Northrup Company of Philadelphia, who have adopted the potentiometer principle, formerly used only for accurate laboratory work. The connections are shown in Fig. 1, where B is a 2-volt accumulator, R, an adjustable resistance, R_2 a fixed resistance, DE a uniform ometer, and A a switch. In order to maintain a steady stretched wire, S a standard cell, G a sensitive galvanfall of potential along DE, R_1 is adjusted so that on switching the standard cell into the circuit of the galvanometer, no deflection is observed. As the voltage of B falls off with use, this adjustment must be made from time to time. The pyrometer is connected to one terminal of the galvanometer and to a sliding contact F, which, in taking a reading, is moved along DE until no deflection is observed on G. From the known relation between temperature and E.M.F. for the junction used, DE may be graduated so as to read temperatures directly. The advantages of this arrangement are greater sensitiveness and independence of the resistance of the pyrometer and leads; the drawback, from an industrial standpoint, is that the readings are not automatic. Several methods for adapting an indicator for special ranges have been devised. In one form, due to the Cambridge Scientific Instrument Company, the indicator takes the place of the galvanometer G in Fig. 1, and by fixing the slider F at a given position—representing, say, 500°—the pointer of the indicator is prevented from moving until this temperature has been reached by the junction. The zero of the indicator is thus made to represent 500°, and by keeping F fixed, the whole of the scale may be utilized for reading from 500° upwards. A more open scale, with correspondingly closer readings, may thus be obtained; and by suitable adjustment of F the range covered may be varied as required. The same firm has also introduced a mechanical device for achieving the same object. In this a suspended-coil indicator is used, and by turning a torsion head a twist is imparted to the suspension, so that the pointer does not move over the scale until the temperature of the junction has reached an assigned figure. In the multi-range instrument made by R. W. Paul, the indicator takes the place of the galvanometer in a Wheatstone bridge circuit, the pyrometer being in series with the indicator. By throwing the bridge slightly out of balance, a current may be made to pass through the indiactor in an opposite direction to that produced by the heated junction; and only when this opposing current is overcome will the pointer begin to move over the scale. Resistances are provided which, when inserted in the arms of the bridge, disturb the balance so as to hold up the indicator until an assigned temperature—say 600°—is reached, when the whole scale becomes available for the selected range. By using two manganin and two copper resistances in the arms of the bridge, automatic correction is made for changes in the temperature of the cold junction. Thus, if the bridge were balanced at 20°, a current would flow through the indicator at any other temperature, as copper changes its resistance on heating or cooling, whilst manganin does not. The resistances are so chosen that the movement of the pointer caused by this current represents the increase or decrease in the temperature of the cold junction, and thus any errors due to this cause are eliminated.

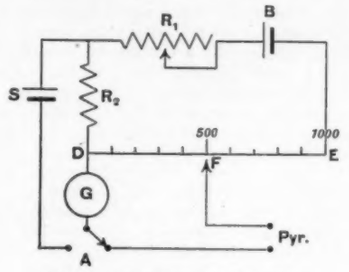

Fig. 1.—Potentiometer indicator

The regulation of the temperature of superheated steam on locomotives has given rise to the problem of producing an indicator practically unaffected by vibrations. This has been solved in various ways by different makers, and satisfactory instruments are now procurable for this purpose. Altogether, great progress has been made in this branch of pyrometry, particularly in the direction of greater accuracy.

RESISTANCE PYROMETERS.

No special change is to be recorded in connection with this class of instrument. The recent work of Sir William Crookes has shown that platinum is distinctly volatile above 1000° C., and this explains satisfactorily why resistance pyrometers were found to change their calibration when used above this temperature. For work at low or moderate temperatures the resistance pyrometer is much used on account of its superior accuracy, which, however, is only operative when the temperature to be measured is subject to precise control. It is now customary to employ thermo-electric pyrometers for the general run of metallurgical work, and to use a resistance pyrometer for very exact work, and for a workship standard within its upper limit--1000° C.

The researches of Northrup on the resistance of molten metals (*Journal of the Franklin Institute*, January and March, 1914) suggest a possible extension of the range of resistance pyrometers by the use of a liquid element. Melted copper, for example, shows a uniform increase in resistance up to 1400° C., and this fact might be utilized in measuring temperatures if a suitable appliance were forthcoming. The decrease in the resistance of pyro-conductors with rise in temperature may possibly be utilized for resistance pyrometers. Alundum, for example, has a resistance of 6100 ohms per cm. cube at 1100° C., which falls to 190 ohms at 1600° C.—an average decrease of nearly 12 ohms per degree, which could easily be detected on a coarse instrument.

RADIATION PYROMETERS.

A distinct improvement in these instruments has been the introduction of pivoted indicators in place of the suspended-coil type formerly in use. This has been made possible by the use of more sensitive junctions to receive the radiations. The Féry pyrometer has been modified by Whipple for determining the temperature of molten metals by mounting the pyrometer at the open end of a fireclay tube, so as to be permanently focussed on the closed end which is immersed in the metal. Foster uses a similar plan in connection with this fixed-focus pyrometer, the end being closed by a salamander tube which is dipped into the metal. The telescope is pierced by a tube open at both ends, through which air may be forced with the view of preventing fumes from reaching and corroding the mirror in the event of breakage of the immersion tube. Mr. R. W. Paul has introduced a radiation pyrometer in which the rays are received in a tube containing a polished cone, a junction at the apex receiving the radiations. This type of instrument, originally due to Thwing, gives the same reading at all distances within a given limit, and therefore requires no focussing. A unipivot galvanometer is used as indicator. A high degree of accuracy has now been attained with radiation pyrometers, as is proved by tests on commercial instruments conducted at the National Physical Laboratory.

OPTICAL PYROMETERS.

The standard forms due to Féry, Wanner, and Holborn and Kurlbaum are now well established, and have been improved in details with a view to industrial use. A new type of optical pyrometer, based on the principle of color extinction, has been introduced. In the form devised by Heathcote in the Research Laboratory of the Rudge-Whitworth Company, cells containing a liquid of the correct color and density are used, so that the luminous rays from the heated object are extinguished at a given temperature. The instrument consists of an eye-shade in which four cells are mounted, two of which are capable of extinguishing the light at the working temperature, whilst the other two correspond to a slightly higher temperature. Either pair may be brought before the eyes by moving a slide, and when the heated object is just visible in the lower pair, but invisible in the higher, the correct temperature has been attained. In another form a single cell is used, in which the depth of liquid may be adjusted until extinction occurs, and the temperature read off on a scale graduated in temperatures according to the depth.

* Abstract of a paper read before the Royal Society of Arts on May 12 by Mr. Chas. R. Darling. Reproduced from *Nature*.

Another form of extinction pyrometer has been designed by Alder and Cochrane (Patent No. 27633, 1913). This consists of a small telescope, the rays through which are intercepted by a wedge of dark-colored glass, which is moved until the sighted object just ceases to be visible. Temperatures are read from a scale which moves with the prism, and the range may be increased by inserting a piece of tinted glass in the eyepiece, and reading from a second scale prepared with the glass in position.

An important paper, embodying results which suggest a new type of optical pyrometer, was read by Paterson and Dudding before the Physical Society in March, 1915. It was shown that the temperature of many metallic substances could be measured by matching the color against that of a black body until identical. A Lummer-Brodhun photometer was used, and the temperature of the black body varied until equality of hue was obtained. Filament lamps, with an ammeter and rheostat in the circuit, were thus matched, and became secondary standards, a given current corresponding to a known temperature. An optical pyrometer on these lines appears quite feasible.

Lovibond has suggested an optical pyrometer in which a standard source of light is brought to equality of tint with the heated object by interposing tintometer glasses.

RECORDERS.

The value of temperature records is now so much recognized in the industries that all makers of pyrometers have given special attention to recorders, and have devised arrangements for registering the readings of several pyrometers simultaneously. For resistance pyrometers the well-known recorder of Callendar is much used, and the modern form of Roberts-Austen photographic recorder, made by the White Instrument Company, is of great service in accurate work with thermo-electric instruments. Of the more recent types Foster's recorder possesses an indicator pivoted horizontally, the pointer being vertical and moving across a circular chart rotating about its center once in twenty-four hours. At short intervals a presser-bar is urged against the pointer, at the end of which is placed a capillary tube containing an inked wick. A mark is thus made on the chart corresponding to the position of the pointer; and as the lines radiating from the center are divided into temperatures, a complete record, visible in its entirety, is made.

The thread recorder of the Cambridge Scientific Instrument Company has been improved in many details. One of the latest forms has two indicators, which are made to record on a single chart wound on a long drum rotated by clockwork. The presser-bar in this case pushes the pointer on to an inked thread, which touches and leaves an ink-dot on the graduated chart. By having two threads, colored with different inks, and a mechanism which brings each thread in turn beneath the pointer, four simultaneous records may be taken, the pyrometers concerned being automatically switched on to the indicators in correct sequence.

A recorder in which the mechanism is driven by a motor has been introduced by the Leeds and Northrup Company, and is much used in the United States. R. W. Paul has also adopted the motor-drive in his new recorder, which also embodies other novel features. The chart is made in the form of a continuous roll, lasting for 1000 hours, a large part of which is open to inspection through a window extension. The pointer is pressed periodically on to an inked ribbon, which touches the chart at a place where the latter is passing over a knife-edge, and hence a dot is produced. Change-gear for altering the speed may be inserted when desired, and duplicate records are secured by means of a second ribbon, of different color, which may be made to alternate in position with the first ribbon beneath the pointer. When a resistance pyrometer is in use, a Harris indicator replaces the galvanometer, a new chart, divided to suit this indicator, being inserted.

In the latest form of Siemens' recorder, a long chart, visible over a considerable length through a window, is also used. It is furnished with a pivoted galvanometer, and the pointer is pressed onto an inked ribbon which touches the chart. Clockwork is used to actuate this recorder.

CONCLUSION.

The substantial advances made in this country in pyrometry during recent years may be cited as a useful guide as to how industry may be created and preserved. All the places at which pyrometers are made in Britain are under the direction of skilled scientific men, who are constantly devising new instruments and finding wider fields for their application. All are in close touch with the National Physical Laboratory, which has proved invaluable to them in securing uniformity of calibration, and in other ways. The result is a thriving and extending industry, not threatened by foreign competition, and not requiring artificial props to ensure its success.

Instability of Electrified Liquid Surfaces *

WHEN commenting on the difficulties of imparting an electric charge to gases in his lectures on "Electrical Properties of Gases,"* Sir J. J. Thomson stated that the vapors of ether, rising from a warm, electrically-charged plate of brass, or mercury vapors given off by a layer of electrified mercury, did not carry any electric charges away with them. Though Sir Joseph did not state a new fact, the statement sounds rather surprising. Some recent experiments made by Prof. J. Zeleny of Yale, though not disproving the fact, show, at any rate, that an electrified liquid surface is in an unstable condition. Zeleny (*Physical Review*, July, 1917, pages 1 to 6) experiments in the following way. He charges a vertical glass tube, 0.92 mm. in diameter, with a liquid (generally alcohol, water is not so suitable) by connecting its upper end with a reservoir of the liquid, and he adjusts the hydrostatic pressure in such a way that drops form at the lower opening of the tube and fall off at a slow rate. The liquid is now charged to a potential of 5,000 volts or more by means of an induction machine, and an earthed metal plate is placed about 2 cm. below the end of the tube. The drop then becomes elongated, more cylindrical than it was, and the instability manifests itself by the formation of a thread of liquid, which hangs downward like a tail, breaks off and contracts into one or more little drops, far smaller than the original drop. Sometimes several tails appear simultaneously. Better to study the phenomena, Zeleny took photographs of the drops at intervals of one-eightieth of a second with the aid of an induction coil circuit comprising a Leyden jar and a mercury jet interrupter. The fine photographs reproduced in the paper enable the reader to watch the phenomenon. There is generally an asymmetry. The thread or tail into which the drop is drawn out appears, say, on the right of the tube and is deflected to the right; on the next photograph the thread, resembling a long, thin cigar, pointed at both ends, has left the tube, and is moving downward, obliquely to the right; then it contracts into two small drops which, in the next picture, unite to one bigger drop, much smaller still than the original drop. The drop then develops a new tail, this time on the left side of the tube and in clined to the left; and so it goes on alternately, the threads being occasionally also vertical. Sometimes the lower ends of the long, then very fine, threads were twisted into loops, breaking up into several drops. Zeleny also observed a drop of the shape of a perfectly symmetrical cone which narrowed down to a thread, only 0.004 mm. in thickness, and then spread out again in a big inverted cone or fan. The simultaneous formation of several threads was noticed particularly with higher potentials, above 5,000 volts; Zeleny speaks of eight and more threads or jets, which in this case appeared stationary for a little while, surrounding the end of the tube like divergent rays. When the liquid in the tube was glycerin, a fine vertical thread formed, which attained a length of 15 mm. before it broke up. This thread was of uniform thickness, while the others looked more like tiny cigars, as we mentioned. The rate at which these threads formed was 3 mm. per second. If any asymmetry should develop anywhere, the electric fields would be disturbed and give rise to further asymmetrical effects. Zeleny mentions, in conclusion, that the old experiment of threads being pulled from highly-electrified molten sealing-wax would doubtless be an example of the action described.—*Engineering*.

Motion of the Air in the Lowest Layers of the Atmosphere

FROM measurements of the wind velocity at five different heights up to 258 meters above the ground at the German wireless telegraph station at Nauen, the law is deduced that wind velocities at different heights vary as the fifth roots of the heights. At 512m. the velocity is twice that at 16m. The diurnal variation of wind velocity at the surface with a maximum in the afternoon extends in winter only to a height of about 60. above the ground. Above that height the opposite type of variation is found, with a maximum in the night. The neutral zone between the two types is considerably higher in the summer, probably at about 300 m.—Note in *Science Abstracts* on an article by G. Hellmann in Preuss. Akad. Wiss. Berlin.

* *See Engineering*, May 11, 1917, page 456

Standard Samples for Thermometric Fixed Points

THE U. S. Bureau of Standards is now prepared to distribute samples of pure tin, zinc, aluminum and copper for use in testing pyrometers used in measuring high temperatures. These metals melt at definite temperatures, and by using the pyrometer to observe the temperature at which the metal melts it is possible to decide whether the pyrometer reads correctly. The accurate measurement of high temperatures has acquired an enormous importance in the metal-working industries; for example, all the more important parts of an automobile are heat-treated, and to obtain the desired qualities in the finished parts these must be subjected to definite temperatures during the process. The standard temperature samples therefore supply standards which are of great value to the industries. It was necessary to obtain very pure materials for these samples, and it is gratifying to find that American manufacturers were able to prepare as pure materials as could be obtained anywhere.

These standards are described in circular No. 66, issued by the Bureau of Standards, which also contains suggestions for their use. The circular con be obtained on request from the Bureau.

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Manufacture of Files

For many years files were made entirely by hand, and at the present time the best files are still made in the same way. The file may be called a metal-cutting or abrasion tool, and it removes the metal by means of a series of sharp-edged parallel ridges all inclined at an angle of about 50 degrees to the axis of the tool. There are numerous types of file differing in fineness of cut. These are all divided into two broad classes of "double cut" and "float cut," or a "single cut." The former have two rows of cutting edges equally inclined to the axis and the latter have only one. In preparing the files steel blanks are first forged from bars which have been previously sheared or rolled to the section require for the tool. The blank is, of course, of soft steel. It is held on the anvil by a strap which passes round the tang, and is held down by the foot of the operator. If the under side has been cut already or is not flat, it is protected from damage by interposing lead or pewter as a soft support. Then, using a chisel which is rather wider than the blank, the operator makes a series of cuts parallel to each other and at the proper angle. The hammer is chosen with great care to be of such a mass as to cause the burr from each cut to rise to the right height. The distance of one cut from the next is gaged by resting the inclined chisel against the last burr when cutting the next. By increasing the slope of the chisel the distance apart of the burr is increased and vice-versa. It is obvious that the greatest skill and practice is required to strike, the chisel with the right force, and to keep its inclination constant over many hundreds of cuts. The height of the burrs as well as their distance from each other governs the fineness or coarseness of the cut. In the ordinary double-cut flat file there are 6 degrees of fineness respectively, called rough, middle, bastard, second cut, smooth, and dead smooth. Float-cut files are made in rough, bastard, and smooth varieties. In making double-cut files the first series of cuts are smoothed over very slighlty before making the second series. Lancashire used to make the best files, and even now no place can compete with it for the finest files, such as watchmakers use. The author of a classic work on the manipulation of metals, mentions a fine Lancashire file on which he counted 300 cuts to the inch.

The rasp cuts in virtue of a number of triangular-shaped projecting burrs distributed over its surface. These are made with a three-cornered pointed punch or chisel. They are distributed as evenly as possible, the great object of the file-cutter being to arrange that one cut shall not come behind another. There is thus great skill in arranging by the eye a pattern in which the number of cuts per square inch shall be uniform and yet in which they they are irregularly placed relative to the axis of the tool. Rasps, again, are made in rough, bastard, and smooth cuts. The wide use of aluminium has brought into use files of the "dreadnaught" type. In these the cut is single and is normal to the axis, or nearly so. It is very coarse, and the teeth are deep and triangle in section. As a rule they are not straight, but are shaped in ares or circles arranged parallel to each other. This coarse type of file is necessary because the aluminium being soft rapidly clogs the teeth of ordinary files, making the edges so that they will not cut. The writer knows an old metal patternmaker who has to file up metal patterns, often on very awkward concave surfaces. For this purpose he takes old files, and, having softened them, cuts straight dreadnought-type teeth with a small three-cornered file. The files are then bent to suit the cavities and corners which have to be worked, and are rehardened by heating and plunging into oil. In this way he has made a most ingenious set of tools by which almost impossible jobs are performed with ease and accuracy. Returning to the orthodox file cut in the softblank, the next process is to straighten the file out accurately. It is then hardened, the teeth being protected from getting burnt in the heating process. After hardening the quality of cut is improved by exposure to a blast of fine sand.

Numerous attempts were made, even in the eighteenth century to devise machines to replace the hand file-maker. These all attempted to imitate his action by means of an arm carrying a chisel, the latter being struck by a hammer which is operated mechanically. The successful machines of the present day carry the blank on a table which advances very slowly under a chisel or hammer which reciprocates rapidly. By varying the rate of transverse of the table the coarseness of the cut can be altered. But it still remains a fact that the hand operator can make the best file, and this is attributed, curiously enough, to the advantage of a certain amount of irregularity in the teeth of a hand-cut file, which it is very difficult, if not impossible, for a machine to imitate. —London *Daily Telegraph*.

Wear in Big Guns

In the current number of *Arms and Explosives* Major T. G. Tulloch (late R.A.) gives an article of much interest at the present time dealing with the wear of large guns. As the author points out, the wear of such guns has a most important influence on the cost of the war, not only on account of the expense of effecting repairs but because such wear leads to inaccuracy of fire and so increases the amount of ammunition expended to attain a definite objective. On this point he says, "In short, if a few thousandths of an inch of steel at the commencement of the rifling of guns, etc., could be prevented from wearing away in so short a time as at present, the reduction in the cost of the war, so far as guns, ammunition, transport, etc., are concerned, is almost incalculable." In dealing with this matter, Major Tulloch differentiates between the damage to the bore near the breech end—damage for which he retains the usual term "Corrosion"—and that near the muzzle which he prefers to call "erosion" as it is a purely mechanical effect. The causes which produce the first-named class of damage are complex, and include the effects of temperature, the form and dimensions of the powder chamber, the chemical and physical qualities of the powder used, the weight of charge and rapidity of fire, the gas escape past the projectile, and the composition and physical properties of the steel used for the inner tubes of the gun. All these matters present many points of interest and they are discussed clearly in the article with which we are dealing. Major Tulloch attaches much importance to the evolution of methods for securing the effective sealing of the gas escape immediately after the firing of the charge, and he makes some suggestions as to the lines on which such a device may be designed. As regards the physical properties of the steel used for the inner tube, Major Tolluch considers that the heat treatment should be subject to the analysis of the steel and the forging effect, and he urges the necessity of obtaining more effective forging of the portion of the tube forming the bore, and suggests certain methods of securing this result. With regard to the erosion near the muzzle due to frictional wear and metallic fouling, it is pointed out that to secure good shooting it is desirable to prevent such fouling by all practicable means, such as slightly bell-mouthing the bore, and, as indicative of the importance of this matter, he states that by electrolytic methods over 15 pounds weight of copper have been removed from the bore of an 8-inch gun after firing just over 100 rounds. In concluding his most interesting article, Major Tulloch remarks that it was written to invite discussion and to call attention to certain matters requiring systematic investigation, and we much hope that it may have this result.—*Engineering*.

Russian Timber Importation in France

Russian wood is largely imported into France, speaking of course of normal times. In 1913 France imported wood to the extent of $35,000,000, in which lumber figured for $28,000,000, and half of the total amount came from Russia. This is introduced mainly by the northern ports. Outside of sawed lumber, the Russian wood includes telegraph poles, mine timber, wood for paper manufacture, etc., as well as a certain amount used for manufacture of matches and for veneering. Oak wood is imported mainly for railroad ties. Wood pulp is also likely to become a prominent article.

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